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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 5834, 5880, 5978, 5986, 6003, 6040–6042, 6088, 6745, and 7032.

5742 (AD-633793) A NEW APPROACH TO NEUTRON ACTIVATION ANALYSIS THROUGH MICRO AND SUBMICRO ELECTROSEPARATION TECHNIQUES. Mark, Harry B. Jr.; Berlandi, Francis J.; Vassos, Basil H.; Neal, Thomas E. (Michigan Univ., Ann Arbor. Dept. of Chemistry). 1965. Contract DA-31-124-ARO(D)-284. 8p. (AROD-5092:2). CFSTI $3.00 cy, $0.65 mn.

An analytical technique that combines the sensitivity of neutron activation analysis with the selectivity of controlled potential electrodeposition is presented. The experimental procedures involved in this method are discussed along with the electrode assembly design that enables the pyrolytic graphite disk electrode to be produced in a reproducible and simple manner. The advantages of this combination technique for trace determination of multicomponent mixtures of metals and its applications to the trace determination of silver in large excesses of cadmium and aluminum and to the simultaneous determination of many of the metal ions present in sea water are discussed. Some of the limitations, such as impurities in the solvent and supporting electrolyte and adsorption of undesired elements, are discussed, and ways of avoiding or circumventing these difficulties are described. (TAB)

5743 (AWRE-Lib–BIB/15) ANALYTICAL CHEMISTRY MANUALS. A BIBLIOGRAPHY AND INDEX TO THEIR CONTENTS. Dowden, W. A. (Atomic Weapons Research Establishment, Aldermaston (England)). Oct. 1966. 114p. Dep. BIS $3.00, HMSO 15s. 0d.

A bibliography of manuals of collected analytical methods, issued as reports, with indexes to the substances determined, materials analyzed, and miscellaneous procedures is presented. The references are in report number order. (auth)

5744 (CEA-R–3015) ENRICHISSEMENT DU TRITIUM PAR DIFFUSION THERMIQUE. I. CALCUL D'UNE INSTALLATION DESTINEE A LA MESURE DU TRITIUM NATUREL. (Tritium Enrichment by Thermal Diffusion. I. Calculation of an Installation for Measuring Natural Tritium). Shimizu, Masami; Ravoire, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1966. 46p. (In French). Dep. mn.

The natural content of tritium is so low that its measurement generally requires a preliminary enrichment. The thermal diffusion on hydrogen was studied as an enrichment method. The installation studied comprised two stages of columns of the hot-wire type, together with a device for transferring the tritium from the water sample into the hydrogen in the columns using catalytic exchange. A complete mathematical treatment for the operation of such a unit was made and programmed for the IBM 7094 computer. An optimization was effected by means of this program. It is shown that for similar performances, less hydrogen was retained in the case of hot-wire type columns than in the case of columns composed of concentric tubes. (auth)

5745 (CEA-R–3029) LA DETERMINATION POLAROGRAPHIQUE DE LA STOECHIOMETRIE DU DIOXYDE D'URANIUM. (Polarographic Determination of Uranium Dioxide Stoichiometry). Viguie, Jean-Claude; Uny, Gisele (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Oct. 1966. 16p. (In French). Dep. mn.

The method described allows the determination of small deviations from stoichiometry for uranium dioxide. It was applied to the study of surface oxidation of bulk samples. The sample is dissolved in phosphoric acid under an argon atmosphere; U(VI) is determined by polarography in H_3PO_4 4.5 $\underline{N}$ – H_2SO_4 4 $\underline{N}$. U(IV) is determinated by potentiometry. The detection limit is $UO_{2,0002}$. The accuracy for a single determination at the 95% confidence level is ±20 per cent for samples with composition included between $UO_{2,001}$ and $UO_{2,01}$. (auth)

5746 (IA–1066) DETERMINATION OF PERMANENT GASES BY GAS CHROMATOGRAPHY. A Preliminary Report. Wiernik, M. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). May 1966. 19p. Dep. mn.

Several methods for the determination of permanent gases are discussed. The two columns – two half detectors method is described and data on retention values and calibration linearity are given. The gases determined included mixtures of H_2, O_2, Ar, CH_4, CO_2, CO, N_2, and SH_2. (P.C.H.)

5747 (IA-1082) RESEARCH LABORATORIES ANNUAL REPORT, JANUARY-DECEMBER 1965. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). June 1966. 374p. Dep. mn.

Twelve sections are included; separate abstracts were prepared for eleven sections. The section on mathematics was excluded. (P.C.H.)

For abstracts of individual sections see: 5834, 5904, 6033, 6144, 6166, 6330, 6331, 6402, 7694, 7880, and 8041.

5748 (JEN–163-DQ/I-56) ESTUDIO DE UN METODO GENERAL DE ANALISIS ESPECTROGRAFICO CUANTITATIVO. (General Method of Quantitative Spectrographic Analysis). Capdevila, C.; Roca, M. (Junta de Energia Nuclear, Madrid (Spain). Division de Quimica). 1966. 10p. (In Spanish). Dep. mn.

A spectrographic method was developed to determine 23 elements in a wide range of concentrations; the method can be applied to metallic or refractory samples. Previous melting with lithium tetraborate and germanium oxide was done in order to avoid the influence of matrix composition and crystalline structure. Germanium oxide was employed as internal standard. The resulting beads were mixed with graphite powder (1:1) and excited in a 10-amp dc arc. The possibility of avoiding previous melting was studied, but this caused a lower precision. (auth)

5749 (JEN–164-DQ/I-57) ANALISIS ESPECTROQUIMICO DE LECTURA DIRECTA DE URANATO SODICO. (Direct-Reading Spectrochemical Analysis of Sodium Uranate). Roca, M.; Capdevila, C. (Junta de Energia Nuclear, Madrid (Spain). Division de Quimica). 1966. 17p. (In Spanish). Dep. mn.

Application of the quantometer to the analysis of sodium uranate is described. To determine boron, cadmium, phosphorus, and molybdenum contents, the samples were mixed with graphite powder (1:30) and excited in a 10-amp dc arc with 4 × 4.5 mm cup graphite rods, using silver as the internal standard. A not-so-deep cup and a dilution factor of 90 were more suitable for calcium, copper, iron, silicon, and vanadium determination; cobalt and chromium were the internal standards. (auth)

5750 (JEN–165-DQ/I-58) ANALISIS ESPECTROQUIMICO DE ALUMINIO Y SUS ALEACIONES Y DE S.A.P. (Spectrochemical Analysis of Aluminum and its Alloys, and S.A.P.). Roca, M. (Junta de Energia Nuclear, Madrid (Spain). Division de Quimica). 1966. 15p. (In Spanish). Dep. mn.

Three different techniques were employed for the spectrochemical analysis of aluminum, aluminum alloys, and SAP. In the point to

plane method with condensed spark and direct reading spectrometry, from the study on instantaneous spectral-line intensities, a long preintegration time was established. In the powdered-samples technique with a dc arc and direct reading spectrometry samples were transformed into Al_2O_3 and mixed with graphite powder (1:1). A complete study on the behavior of the different elements in aluminum oxide, aluminum sulfate and their mixtures with graphite, was carried out. A carrier-distillation method was used for very low concentrations of boron and cadmium in SAP. (auth)

5751 (JUL-410-ST) SCHNELLBESTIMMUNG VON RADIOJOD IN NATUERLICHEN WAESSERN. (Rapid Determination of Radioiodine in Natural Waters). Jacobs, H.; Lehmann, D. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). Sept. 1966. 14p. (In German). Dep. mn.

Isotopic exchange is proposed as an improved method for the rapid determination of radioiodine in natural waters. The influence of the water matrix is discussed. The mean recovery of the method is 79% and the detection limit 10 pCi/l. The required time for one determination including calculation is 10 minutes. (auth)

5752 (KAPL-M-6577) SINGLE PAN BALANCE WEIGHING OF CORROSION COUPONS. Callahan, E. J.; Titus, A. C. (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 30, 1966. Contract W-31-109-eng-52. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A procedure has been derived to verify the Class S tolerances of the internal balance ring weights of a single-pan semimicro analytical balance, since gravimetric effects of corrosion can be observed more accurately when the analytical balance used to make gravimetric measurements is periodically calibrated. These procedures assure that anticipated small weight differences will be detected even though these values are close to the weighing accuracy of the balance. (auth)

5753 (LA-3559) DISTILLATION SEPARATION AND SPECTROPHOTOMETRIC MEASUREMENT OF MICROGRAM QUANTITIES OF SILICON. Marshall, T. K.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex.). Sept. 15, 1966. Contract W-7405-eng-36. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Microgram quantities of silicon are measured spectrophotometrically as the silicomolybdic acid complex following separation from plutonium and other elements by distillation as silicon tetrafluoride. The distillation is done in a platinum still to avoid contamination of the sample. The silicon tetrafluoride is collected in a dilute solution of boric and molybdic acid to form silicomolybdic acid which is reduced with a 1-amino-2-naphthol-4-sulfonic acid–sodium bisulfite solution. The absorbance of the reduced complex is measured at a wavelength of 825 mμ. Based upon 14 determinations each of 2.08, 5.2, 10.4, 20.8, and 31.2 μg of silicon, the relative standard deviation of the method was found to be 16, 10.1, 2.8, 2.1, and 2.1%, respectively. The molar absorptivity of 19,400 calculated from these data shows that 2 ppM (2 μg of silicon in a 1.0-g plutonium sample) can be determined reliably. The method tolerates at least 1 g of plutonium and 100 mg of several other elements. Most serious interference is caused by aluminum, iron, and zirconium. (auth)

5754 (LA-3603) THE DETERMINATION OF FREE (UNCOMBINED) CARBON IN PLUTONIUM CARBIDES. Marshall, T. K.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex.). Aug. 10, 1966. Contract W-7405-eng-36. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Free (uncombined) carbon in plutonium carbide is determined gravimetrically following dissolution of the sample in hydrochloric acid and ignition of the free carbon to carbon dioxide at 1000°C in oxygen. The plutonium carbide is placed on an asbestos mat held by a perforated porcelain disc near the bottom of a 55-mm length of fused silica tubing and dissolved in hydrochloric acid. The tars formed by this dissolution are washed from the mat with acetone. The filter tube is dried under heat lamps and placed in a tube furnace for oxidation of the carbon to carbon dioxide which is absorbed in an Ascarite-filled tube and weighed. Relative standard deviations for determinations of free carbon in four plutonium carbide samples were in the range of 6 to 11%. These percentages include differences in results caused by possible heterogeneity of the samples in addition to deviations inherent in the method of measurement. It was concluded that the relative standard deviation of the method was no greater than 10%. (auth)

5755 (LA-DC-7743) A COMPARISON OF THREE METHODS OF OXYGEN CONCENTRATION MEASUREMENT IN SODIUM. McPheeters, Charles C.; Williams, James M. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 35p. (CONF-661110-5). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria.

Two electrochemical oxygen meters, an ac resistivity meter, and a vacuum distillation sodium sampler were tested to determine their sensitivities and responses to oxygen concentration changes in sodium. These tests were conducted on an isothermal, forced convection sodium loop of large volume; a bypass cold trap provided for oxygen concentration control. A vacuum distillation analytical technique was used as the primary standard for measurement of the oxygen concentration. Experimentally determined calibration curves for the electrochemical cells agree closely with the theoretical predictions in the slope, but the emf values were approximately 85% of theoretical. The ac resistivity meter was calibrated by comparing per cent resistivity with vacuum distillation and analyses. The meter was found to have an oxygen concentration dependence of 0.0070% resistivity change per ppM weight change in oxygen concentration, compared to the predicted value of 0.01%. Later in the experiment this dependence was found to be 0.0139% resistivity change per ppM oxygen. This shift is attributed to the effect of other impurities added to the system. In order to determine the response times of the oxygen meters and the resistivity meter, a step change was made in the cold trap temperature. Within the error of the measurements, all instruments responded in good agreement with the vacuum distillation analyses. The total time elapsed from the beginning of the concentration transient to system equilibrium was 130 ± 10 hours. The efficiency for oxygen addition to the system from the cold trap was found to be 20%. (P.C.H.)

5756 (NBS-TN-404) RADIOCHEMICAL ANALYSIS: ACTIVATION ANALYSIS, INSTRUMENTATION, RADIATION TECHNIQUES, AND RADIOISOTOPE TECHNIQUES, JULY 1965–JUNE 1966. DeVoe, James R. (ed.) (National Bureau of Standards, Washington, D. C.). Sept. 30, 1966. 238p. GPO $1.25.

Pertinent information on the irradiation facilities of the nuclear reactor, Linac, and Cockcroft–Walton generator are described. A number of analyses of standard reference materials by activation analysis are described (e.g., Cu in cast iron, SRM 82b; Se in selenium steel, SRM 1170; Al in steel, SRM 14e; and V in stainless steel, SRM 73c). Various aspects of the technical problems in activation analysis such as its use for homogeneity testing, production of suitable flux monitors, and experimental design with respect to increasing selectivity (such as by using variable neutron energy) and reducing systematic and random errors, are presented. A realistic procedure for estimating sensitivity and for designing the analysis to optimize the detection limit is described. A computer program that resolves complex decay curves utilizes parameter changes convenient for the conversational aspect of "time sharing" digital computers. A highly specific radiochemical separation for copper using a type of amalgam exchange is described. Description of specialized data handling equipment as well as information on a fast rise preamplifier, solid state detector system, and other special instruments such as a pneumatic transport system rabbit sensor, are presented. A description of the laboratories used in Mössbauer spectroscopy is also included. Special problems in radiation detection for use in a spectrometer are also described. The Standard Reference Material Program for chemical shift in Mössbauer spectroscopy is discussed with particular reference to the search for a tin standard. The computer program, "Parlors M," that is used for resolving complex Mössbauer spectra is presented in its entirety in Appendix II. The use of thin layer chromatography in conjunction with radioactive reagent analysis for trace elements is described. Substoichiometric radioisotope dilution continues to be studied by evaluating systematic and random errors, as well as by developing the technique from physico-chemical principles such as controlled potential coulometry. (auth)

5757 (NP-16377) THE SIMULTANEOUS DETERMINATION OF AMMONIUM, FLUORINE, AND ZIRCONIUM IN AMMONIUM HEXAFLUOZIRCONATE SOLUTIONS. Moeken, H. H. Ph.; Van Neste, W. A. H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Sept. 1966. 11p. (ETR-195). Dep. mn. CFSTI $3.00 cy, $0.50 mn.

A method is described for determining the ammonium, fluorine, and zirconium concentrations in decladding solutions produced in irradiated fuel reprocessing. The three constituents are determined simultaneously by acidimetric titration against sodium hydroxide solution. A recording titrator is used, which records the hydroxonium concentration, indicated by a glass electrode, as a function of the volume of base added. The amounts of base corresponding to relevant points of inflexion on the curve and the slopes of the curve near these points are empirically related to the concentrations of the three constituents. The method is easily adaptable for remote control, enables full use to be made of expensive laboratory space, and gives a quick analysis which is sufficiently precise. (auth)

5758 (NP-16378) ABSORPTIOMETRIC DETERMINATION OF MICROGRAM AMOUNTS OF URANIUM WITH RHODAMIN B. Moeken, H. H. Ph.; Van Neste, W. A. H. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Sept. 1966. 13p. (ETR-196). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Hexavalent uranium is extracted as a complex with Rhodamine B into a benzene-ether-hexone solvent from a benzoate buffer. Optimum conditions for the color development were established, leading to a molar absorptivity of 102700 $mmol^{-1}$ cm^2 at 555 nm, the highest yet reported for a uranium complex. The determination of uranium concentrations ranging from 0.02 to 3 μg per ml in nitrate samples is described. The precision of the method, expressed as relative standard deviation, has a range from 20 to 0.6%. The interference of iron is discussed. (auth)

5759 (NRL-6427) PROCEDURES FOR THE ANALYSIS OF METALS, ALLOYS, AND OTHER MATERIALS OF RESEARCH. PART 2. DETERMINATION OF SILVER AND INDIUM IN MAGNESIUM-BASE ALLOYS, LEAD IN INDIUM, AND ZIRCONIUM IN HAFNIUM. Gates, O. R.; Brooks, E. J. (Naval Research Lab., Washington, D. C.). May 3, 1966. 15p.

A series of methods is presented in sufficient detail for direct analytical application to the determination of silver and indium in magnesium-base alloys, lead in indium, and zirconium in hafnium. The analytical approaches are combinations of chemical and instrumental techniques involving the flame spectrophotometer, the polarograph, and the x-ray fluorescence equipment, respectively. (auth)

5760 (PG-Report-755) ANALYTICAL METHOD FOR THE DETERMINATION OF TRI-ISO-BUTYL PHOSPHATE IN TRI-NORMAL-BUTYL PHOSPHATE (GAS CHROMATOGRAPHY). (United Kingdom Atomic Energy Authority, Annon (Scotland). Production Group). 1966. 8p. Dep. BIS $0.30, HMSO 1s. 3d.

The sample is mixed with n-tridecane and part of the mixture injected into an Apiezon L chromatographic column maintained at 200°C. After the components have been eluted from the column the ratio of the height of the n-tridecane peak to the height of the triisobutyl phosphate peak is used to determine the concentration of triisobutyl phosphate in the sample. (auth)

5761 (PHS-999-RH-17) RADIONUCLIDE ANALYSIS OF LARGE NUMBERS OF FOOD AND WATER SAMPLES. Ferri, Esther; Magno, Paul J.; Setter, Lloyd R. (Public Health Service, Washington, D. C. Div. of Radiological Health). Dec. 1965. 36p. Public Health Service Free.

The processing of food and water samples, as conducted at the Northeastern Radiological Health Laboratory, is described. Included are manpower and equipment requirements, and technical procedures for measurements of appropriate radioactivities. Procedures described include techniques for a series of radionuclides, as well as certain stable elements in food, and for gross alpha and beta determinations, gamma spectral analyses, and radium-226 and strontium-90 in water. (auth)

5762 (RISO-138) PRE-IRRADIATION SEPARATION FOR THE DETERMINATION OF VANADIUM IN BLOOD SERUM BY REACTOR NEUTRON ACTIVATION ANALYSIS. Heydorn, K.; Lukens, H. R. (Danish Atomic Energy Commission, Risoe. Research Establishment). June 1966. 20p. (CONF-651101-87). Dep. mn.

From 13th Conference on Remote Systems Technology, Washington, D. C.

A procedure for the determination of vanadium in an inorganic matrix, such as may result from the decomposition of biological samples, is described. The method utilizes purely instrumental thermal-neutron activation analysis preceded by separation of vanadium from interfering elements by extraction with 8-hydroxyquinoline. Samples of human blood serum were analyzed by the aid of dry-ashing as well as wet-ashing techniques. Dry ashing in porcelain crucibles introduced significant amounts of vanadium into the samples, and subsequent analysis of the porcelain glaze showed a vanadium content of ~2 $\mu g/cm^2$. Analytical results from samples ashed in quartz crucibles or by wet ashing showed a mean value of 0.0046 ± 0.0008 microgram of vanadium per milliliter of human blood serum. (auth)

5763 (TID-22381) LARGE VOLUME CONTINUOUS STREAM SAMPLER FOR RADIOACTIVE MATERIALS. Landon, L. F. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Oct. 21, 1965. Contract AT(07-2)-1. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A sampler, capable of collecting radioactive materials directly from a large volume of water on an ion exchange column, was developed to operate on streams remote from electrical power. Radiochemical and gamma spectrometric analyses of the ion exchange column permit determination of very low concentrations of radionuclides without handling large volumes of water. A paddle wheel on the sampler drives two positive-displacement pumps. One pump is geared to deliver one gallon of water per week to a two-gallon container attached to the sampler. The second pump is geared to deliver up to 50 gallons of water per week to an ion exchange column. A prefilter is necessary to prevent column plugging when sampling streams with high sediment load. The throughput of the column is calculated from the volume of water collected in the two-gallon container and the gear ratio of the two pumps. (auth)

5764 (UCID-15039) DETERMINATION OF IMPURITIES IN MOLYBDENUM BY EMISSION SPECTROSCOPY. Albin, E. E.; Morris, W. F. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 5, 1966. Contract W-7405-eng-48. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The principle of establishing excitation conditions that favor the impurity spectra while suppressing the matrix spectrum was applied to the analysis of Mo with some modification of electrode configuration and arc conditions. The formation of Mo_2C in the electrode crater was optimized, thus reducing considerably the overshadowing of impurity lines by Mo. (P.C.H.)

5765 (USNRDL-TRC-84) THE PAPER ELECTROPHORESIS OF THE IRON(II)-IRON(III) SYSTEM. Lingren, W. E.; Reeck, G.; Marson, R. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 26, 1966. Contract AT(49-5)-2084. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The iron(II)-iron(III) equilibrium mixture in a sulfuric acid solution of pH 2.6 is separable by paper electrophoresis. An attempt was made to determine whether the electrophoretic system affected this equilibrium. Maximum differences of about 10% from the iron(II)-iron(III) true equilibrium ratio were observed after the separation by paper electrophoresis. (auth)

5766 (Y-1560) DIRECT ESTIMATION OF FREE FLUORIDE ION IN TWENTY PERCENT NITRIC ACID ETCHING SOLUTIONS. Dietrich, W. C. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Dec. 8, 1966. Contract W-7405-eng-26. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Free fluoride ion was estimated directly in twenty percent nitric acid solutions containing fluoride, aluminum, beryllium, niobium, zirconium, and uranium ions by correlating the dissolution times of zirconium foils or siliceous films to reactive free fluoride ion. (auth)

5767 (NP-tr-1450) GAS CHROMATOGRAPHIC INVESTIGATION OF HYDRAZINE IN AQUEOUS SOLUTION. Proesch, U.; Zoepfl, H.-J. Translated by D. Verdin (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Chem., 3: 468-9(1963). 7p. Dep. mn. JCL $1.10 fs, $0.80 mf.

A gas chromatographic method was developed for studying the products formed in the radioinduced decomposition of hydrazine and aqueous hydrazine solutions. The results showed that in the analysis of ammoniacal hydrazine solutions, three peaks, which correspond to ammonia, water, and hydrazine, are to be expected. (P.C.H.)

5768 (ORNL-tr-1468) APPLICATION OF AMPEROMETRY IN THE KINETIC METHODS OF ANALYTICAL CHEMISTRY. I. CATALYTIC DETERMINATION OF SMALL AMOUNTS OF MOLYBDENUM. Jedrzejewski, Wtodzimierz. Translated for Oak Ridge National Lab., Tenn., from Chem. Anal. (Warsaw), 5: 207-14(1960). 12p. Dep. mn. JCL $1.60 fs, $0.80 mf.

The amperometric method with two polarized electrodes was used for the registration of time variations of the iodine concentration in the course of a reaction between dilute solutions of hydrogen peroxide and potassium iodide in the presence of sulfuric acid, catalyzed by small quantities of molybdenum(VI). The curves for current strength-time showed a linear character in the course of 2 to 3 min and the angle of inclination (α) of the curves depended on the molybdenum concentration. This dependency on molybdenum concentration furnished the standard curve for the determination of the unknown quantities of molybdate. Quantities from 2.8×10^{-8} to 1.4×10^{-7} g/ml of Mo were determined. The method furnished reproducible values. The error of the determination did not exceed ±6%. The current strength-time curves were recorded successfully with an automatic polarograph with the use of the two platinum indicator electrodes. (auth)

5769 DETERMINATION OF ^{90}Sr RADIOACTIVITY IN TAIWAN FOODSTUFFS. Wang, Ung-Ping (Union Industrial Research Inst., Taiwan, China). Hua Hsueh No. 3, 65-70(Sept. 1965). (In Chinese).

Seventeen varieties of Taiwan foodstuffs were investigated for ^{90}Sr content. Samples were collected from Hsinchu, Taipei, and Tainan areas from October 1963 to April 1964 and ashed in a steel dish; combustion was completed with a porcelain crucible in an electric oven. The ^{90}Sr content of the samples was concentrated by

precipitation methods. The β radioactivity of each specimen was then measured with a G-M counter (RCL Model 10104, mica window 1.1 mg/cm^2). The presence of ^{90}Sr was confirmed by determining the maximum energy and by measuring the half life of the daughter nuclide, ^{90}Y, which had been collected by milking from the mother nuclide. It was found that tea leaves had the highest ^{90}Sr radioactivity, 0.83 pCi/g ash for black and green tea and 0.47 pCi/g for Wulong tea. These values were lower than that of Japanese tea leaves as reported by Shiokawa and Yagi. The other foodstuffs, such as fresh cows' milk, pork, rice and rice hulls, potato, sweet potato, green bean, tomato, and cabbage, showed low ^{90}Sr radioactivity (0.02 to 0.22 pCi/g ash). All determined values of ^{90}Sr radioactivity were below the maximum permissible radioisotope concentrations established by the International Commission on Radiological Protection in 1959. (BBB)

5770 INDUSTRIAL APPLICATIONS OF RADIOISOTOPES. Taylor, K. J. (Wantage Research Lab., Eng.). Rep. Progr. Appl. Chem., 50: 131-43(1965).

Developments in the use of radioisotope techniques in analysis are chiefly considered, although other applications are covered in the extensive bibliography. Topics covered include: activation analysis, x-ray fluorescence analysis, coal ash, tracer applications, and radioisotope power development. (UK)

5771 CONTRIBUTION TO THE DETERMINATION OF THE EQUIVALENCE POINT AND OF THE SOLUBILITY PRODUCT IN RADIOMETRIC AND SIMILAR PRECIPITATION TITRATIONS. Klas, Jan (Katedra Anorganickej Chemie, Bratislava). Chem. Zvesti, 20: 523-9(1966). (In Czech).

The theory of precipitation titrations from the viewpoint of direct equivalence point determination in dilute solution and that of determination of solubility products under the same conditions is examined. An equation is devised with a coordinate system such that the titration curve is described by a straight line whose slope gives the equivalence point and whose x-intercept determines the solubility product for an insoluble compound A_mB_n. These expressions may be used for titration of either A or B. Determination of the solubility product is not necessary for evaluation of the equivalence point for a very dilute solution. The equivalent consumption of titrant is determined from experimental variables, and the solubility product may be determined from the same data. The rules will be verified by experimental application to TlBr. (BBB)

5772 ACTIVATION ANALYSIS IN PROCESS CONTROL. Gray, A. L. (Elliott Automation Nucleonics, Eng.). Control., 11: 19-23(Jan, 1967).

Activation analysis is discussed as a technique for industrial process control. Like other physical analysis techniques it is restricted to certain elements, but they include many low-atomic-number elements difficult to analyze otherwise. The cost of equipment is high, but the principal applications are to continuous nondestructive testing or analysis of inaccessible materials, and large quantities can be handled, so the capital cost of the equipment is not considered a serious drawback. Activation techniques offer opportunities for completely automatic analysis. (auth)

5773 A CONTRIBUTION TO ANALYSIS BASED ON ISOTOPIC DILUTION OF A RADIOACTIVE MATERIAL. II. Klas, Jan (Katedra Anorganickej Chemie, Bratislava). Chem. Zvesti, 20: 530-7(1966). (In Czech).

The accuracy of the double isotopic dilution method of Bloch and Anker and of Zimakov and Rozhavskii was investigated. An equation developed for the relative deviation of the analysis combines the relative deviations of the added quantities of material and the relative deviation of the determinations of specific activity. The equation is adaptable to simple methods of isotopic dilution. It is shown that the maximum accuracy for the double dilution method is achieved at the same set of conditions as for simple dilution. The general accuracies of both methods are compared, and the relative accuracy of the double method is found to be less than that of the single method by a factor of at least (1 + dilution factor for second step). The equations are set up in forms for practical application for constant number of decompositions and for constant time. The relative deviation is minimal when $(i_1/i_2) - 4$ (i = 1 + dilution factor), so that if i_2 is constant, this may serve as an optimization for analytical conditions. (BBB)

5774 INTERFERENCE BY SILICONE POLYMERS IN GAS-SOURCE MASS SPECTROMETRY. Richards, J. R. (Australian National Univ., Canberra). Vacuum, 16: 310-11(1966).

Observations showed that silicones yield a wide range of decomposition products, either by thermal degradation or by interaction with reactive chemical species. Not only do they complicate the interpretation of mass spectra, but they present the possibility of deposition of silicon in significant amounts in regions where ionic reactions may occur, such as pressure gage or ion source. This is presented as an argument for the discontinuance of their use in mass spectrometry, and it is suggested that silicones may cause trouble in any vacuum system that involves the production of ions. Evidence is presented that silicone degradation products interfere in the accurate measurement of lead isotope ratios by mass spectrometry of tetramethyllead. This interference may have contributed to the wide fluctuations in lead isotope ratio reported by workers who used this technique. The problem is illustrated by the mass spectrum of tetramethyllead beside the spectrum of a sample of this impurity obtained in an early abortive attempt to synthesize the lead compound. All the illustrated mass groups could be obtained by depolymerizing silicone grease with KOH, and the peaks around m/e 281 probably correspond to the siloxane tetramer (Si_4O_4 ring, with 7 attached CH_3 groups), and the peaks around m/e 265 and m/e 249 could correspond to the substitution of some of the silicons by carbon. The identity of the latter 2 groups was demonstrated. (BBB)

5775 SIMPLE METHOD FOR THE DETERMINATION OF THE SPECIFIC ACTIVITY OF CARBON DIOXIDE IN BLOOD. Hinks, N. T.; Mills, S. C.; Setchell, B. P. (CSIRO, Prospect, New South Wales). Anal. Biochem., 17: 551-3(Dec. 1966).

A method was developed making possible the determination of concentration and specific activity of carbon dioxide in blood to be done on one sample. Glass screw-top vials, which fit a liquid scintillation counter, were used. The screw top was replaced by a rubber bung in which was fixed a coil, formed by winding stainless steel wire tightly around a piece of metal rod. The coil held a reaction vessel consisting of the lower half of a flat-bottomed vial or ampoule. The analysis for carbon dioxide content was basically the same as previously reported by Conway (Microdiffusion Analysis and Volumetric Error 4th ed., p.201). After determination of carbon dioxide content, ethylenediaminetetraacetic acid (EDTA) and Triton X-100–toluene containing a scintillator was added and the ^{14}C counted. Results were in good agreement with those from existing methods of analysis. (D.H.M.)

5776 PROLINE METABOLISM IN ESCHERICHIA COLI. IV. PREPARATION OF PROLINE-2- AND PROLINE-5-^{3}H AND LOCATION OF ^{3}H IN PROLINE. Frank, Leonard (Johns Hopkins School of Hygiene and Public Health, Baltimore). Anal. Biochem., 17: 423-33(Dec. 1966).

The location and quantitation of tritium in proline were achieved by successive oxidation of proline to γ-aminobutyric acid and thence to β-cyanopropionic acid. Although tritium kinetic isotope effects, whose magnitudes were estimated, attend the oxidations, the method can give unbiased results. Syntheses of proline-2-^{3}H and proline-5-^{3}H are described and, parenthetically, a new approach to the preparation of Δ^1-pyrroline-5-carboxylate is given. (auth)

5777 APPARATUS FOR DECONTAMINATION OF SCINTILLATION COUNTING VIALS. Drosdowsky, Michel; Egoroff, Nicolas (Faculte de Medecine, Paris). Anal. Biochem., 17: 365-8(Dec. 1966).

An apparatus for the rapid and effective decontamination of liquid scintillation vials is described in detail. Only vials that contained less than 10,000 cpm of ^{14}C or ^{3}H are recovered. (auth)

5778 SELF-CONSISTENT MASS ABSORPTION CORRECTION FOR SILICATE ANALYSIS BY X-RAY FLUORESCENCE. Holland, J. G.; Brindle, D. W. Spectrochim. Acta, 22: 2083-93 (Dec. 1966).

A method is described using the approximate composition of the unknown sample, which is calculated by direct reference to a standard, to determine the total mass absorption of the unknown for each operational wavelength. This information is then used to make a more accurate estimate of the composition, which provides for determining a yet more accurate value for the total mass absorption at each wavelength. Thus, by iterative process, a self-consistent chemical composition is obtained, and this value is then corrected for other deviations from proportionality by reference to a set of standards, using a quadratic regression relationship. Although this method was applied only to whole-rock analyses, its application could prove much more extensive. By simple modifications to the existing computer program, analyses could be made within the entire range of the x-ray spectrum. (auth)

5779 ANALYSIS OF METALLURGICAL RAW MATERIALS BY β-RAY BACKSCATTERING. Jirkovsky, R. (Inst. of Mining, Ostrava, Czech.). Hutn. Listy, 20: 506-9(1965). (In Czech.).

Application of the technique to the analysis of ferrosilicon, chromium ores, and chromium and tungsten slags is reviewed. (20 references.) (Analytical Abstr.)

5780 THE DETERMINATION OF COPPER IN ZINC MATERIALS BY NEUTRON ACTIVATION ANALYSIS USING THE

$^{65}Cu(n,\gamma)^{66}Cu$ REACTION. Tomura, Kenji; Higuchi, Hideo (Rikkyo Univ., Yokosuka, Japan). Anal. Chim. Acta, 37: 33-41(Jan. 1967).

The nondestructive and destructive determinations of copper in zinc materials by neutron activation using $^{65}Cu(n,\gamma)^{66}Cu$ reaction are described. Observed cross sections of $^{64}Zn(n,p)^{64}Cu$ and $^{66}Zn(n,p)^{66}Cu$ reactions for fission spectrum neutrons were 28 and 0.51 mb respectively. A double irradiation technique with one sample wrapped in cadmium foil and another bare, was employed for the correction of concurrent formation of ^{66}Cu by (n,p) reaction. One hundred ppM of copper in zinc sulfide was determined nondestructively by γ spectrometry using a thermal flux of 5×10^{11} n/cm^2/sec, while 0.5 ppM of copper in zinc was determined by a thermal flux of 2.5×10^{10} n/cm^2/sec, and by a rapid chemical separation involving copper(I) thiocyanate precipitation. The proposed activation procedures were compared with the spectrophotometric dibenzyldithiocarbamate procedure. (auth)

5781 CADMIUM DETERMINATION IN THORIUM NITRATE BY LINEAR CHRONOAMPEROMETRY WITH ANODIC REDISSOLUTION. Khasgiwale, K. A. (Atomic Energy Establishment, Bombay); Molina, R. J. Electroanal. Chem., 13: 144-8(Jan. 1967). (In French).

Linear chronoamperometry by anodic stripping was applied to the determination of cadmium in solutions of thorium nitrate with K_2CO_3 or KCl–HCl as supporting electrolyte. The effect of supporting electrolyte concentration on the oxidation current is discussed. (auth)

5782 DETERMINATION OF TRACE QUANTITIES OF SCANDIUM IN SILICATE ROCKS BY A COMBINED ION EXCHANGE-SPECTROPHOTOMETRIC METHOD. Shimizu, Tsuneo (Gunma Univ., Japan). Anal. Chim. Acta. 37: 75-80(Jan. 1967).

A spectrophotometric determination of scandium in silicate rocks was developed with Arsenazo as the color reagent. After decomposition of samples with a hydrofluoric–perchloric acid mixture, traces of scandium were separated from interferences by cation- and anion-exchange in acid sulfate media and anion exchange in hydrochloric acid solution. The successive 3 steps, with an intermediate concentration step, yield scandium in a sufficiently pure state for spectrophotcmetric determination. (auth)

5783 ACTiVATION ANALYSIS: RAPID DETERMINATION OF GOLD IN SEA WATER. Cappadona, Carmelo (Univ., Palermo, Italy). Atti Accad. Sci., Lettere Arti Palermo, Pt. 1, 24: 71-4(1963/64). (In Italian).

Gold determination in seawater by activation analysis using a low neutron flux is suggested. The gold is separated with a carrier in the metallic state without radioactive impurity and with good yield. (M.C.G.)

5784 DETERMINATION OF THE QUANTITY OF TWO ELEMENTS CONTAINED IN A MATERIAL BY NEUTRON ACTIVATION ANALYSIS, WHEN THERE IS A SMALL DIFFERENCE IN THEIR HALF LIVES. Agelao, G.; Dardanoni, Z. Tesauro (Univ., Palermo, Italy). Atti Accad. Sci., Lettere Arti Palermo, Pt. 1, 24: 85-94(1963/64). (In Italian).

An investigation was made of the determination by activation analysis of the ratio of two elements mixed in a single sample, in a special case. When the half-lives of the two radioisotopes in the mixture are only a little different, the graphic method applied to the decay curve plotted on semi-log paper appears inadequate. When the isotope having the shorter life has completely decayed, the activity of the longer-lived isotope is also reduced. Therefore, the last part of the curve is formed by scanty and uncertain points. A calculation method was studied, which is considered more reliable. (auth)

5785 COLORIMETRIC DETERMINATION OF SCANDIUM, YTTRIUM, AND LANTHANUM WITH AMMONIUM PURPURATE AS A CHROMOGENIC REAGENT. Sangal, Satendra P. (Univ. of Allahabad, India). Microchem. J., 11: 508-12(Dec. 1966).

Photometric determinations of scandium, yttrium, and lanthanum, with ammonium purpurate (murexide) as a chromogenic reagent, are described. The details of the determination of absorption spectra of the chelates, the effect of pH on the absorbance at λ_{max}, the range for adherence to Beer's law, and sensitivity were worked out. (auth)

5786 COMPLEXOMETRIC DETERMINATION OF THORIUM(IV) WITH 4-(2-PYRIDYLAZO)RESORCINOL, ALIZARIN 3-SULFONATE AND SULFOHYDROXY DIMETHYL FUCHSONE DICARBOXYLIC ACID AS INDICATORS. Sangal, G.; Sangal, S. P.; Mushran, S. P. (Univ. of Allahabad, India). Microchem. J., 11: 513-16(Dec. 1966).

Complexometric determinations of thorium by titrating with EDTA are described. Alizarin 3-sulfonate, sulfohydroxy dimethylfuchsone dicarboxylic acid, and 4-(2-pyridylazo)resorcinol were used as chelatochrome indicators. The optimum conditions for titration with these reagents as indicators, which include the effect of concentration of the indicator, effect of pH, effect of dilution, and some typical results, are described. (auth)

5787 POTENTIOMETRIC TITRATION OF CATIONS WITH EDTA AND USE OF A SILVER ELECTRODE. Strafelda, F. (Technical High School for Chemistry, Prague). Collect. Czech. Chem. Commun., 30: 2320-6(1965). (In German).

Cations that form with EDTA a complex of stability equal to or greater than that of the complex with Ag^+ can be determined potentiometrically in $Na_2B_4O_7$ medium, containing $\simeq$1 μmole of the Ag complex, and with a silver electrode. Ba, Bi, Ca, Cd, Ce^{IV}, Co, Cu^{II}, Hg^{II}, La, Mg, Mn, Ni, Pb, Sr, and Zn were determined by direct titration; Al, Th, Tl, and Zr were determined by back-titration of excess EDTA with Mg, Ca, or Cd. Cations that form stable complexes with EDTA and NH_4^+ interfere; Al can be masked with F^-. This method is suitable for determining Ca and Mg in milk. (Analytical Abstr.)

5788 POLAROGRAPHIC AND AMPEROMETRIC METHODS APPLIED TO METALLURGICAL ANALYSIS. Hitchen, A. (Dept. of Mines and Technical Surveys, Ottawa). Can. Mining Met. Bull., 58: 641-4(1965).

Methods are outlined for the determination of Cu, Ni, Co, Zn, Pb, Cd, Bi, Mn, U, Mo, V, SO_4^{2-}, and F^- in ores, solutions, concentrates, rock samples, and alloys by both polarography and amperometry. (Analytical Abstr.)

5789 NEUTRON-ACTIVATION DETERMINATION OF SILVER IN ORES AND ROCKS. Stefanov, G; Nenov, N.; Zhikov, Z.; Mihailov, M.; Popov, Ch.; Georgiev, N.; Tomov, T. G.; Toelgyessy, J. (Geological Research Inst., Sofia). Compt. Rend. Acad. Bulg. Sci., 18: 425-8(1965).

The sample and standard were irradiated for 50 hr in a thermal-neutron flux of $\simeq 5.4 \times 10^{11}$ neutrons per cm^2 per sec, allowed to decay for 2 days, then fused, together with a carrier, with a 5-fold amount of Na_2O_2. After a relatively short chemical treatment of the melt, the Ag was precipitated and weighed as AgCl. The activity of the 0.656-MeV γ peak was measured in a 400-channel pulse-height analyzer. The method is sensitive to $\simeq 2 \times 10^{-7}$ g of Ag. (Analytical Abstr.)

5790 SEPARATION OF AMERICIUM AND CURIUM FROM RARE EARTH CARRIERS BY ION FOCUSING ELECTROPHORESIS. Gee, H. Y.; Heimbuch, A. H.; Nathans, M. W. (Tracerlab, Inc., Richmond, Calif.). Anal. Chem., 39: 98-100(Jan. 1967).

A rapid and simple application of ion focusing electrophoresis was developed for the separation of Am and Cm from La. Effects of migration time, acid concentration, pH, current density, carrier concentration, and degree of contamination were studied. Recovery of 85% was consistent, and equipment and solutions were reusable after careful cleaning. Although separation of Am from Cm was not good, some fractionation occurred with Am migrating slightly faster than Cm. Results from pulse height analyses revealed no evidence of fractionation when the Am–Cm sections of electrophorograms were dissolved together and electroplated after separation from La. The use of ^{241}Cm as a yield tracer for ^{241}Am remains valid. (P.C.S.)

5791 DETERMINATION OF TRITIUM-LABELLED COMPOUNDS ON THIN-LAYER CHROMATOGRAMS. Bleecken, S.; Kaufmann, G.; Kummer, K. (Inst. for Microbiology and Experimental Therapy, Jena, Ger.). J. Chromatog., 19: No. 1, 105-13 (1965). (In German).

The direct determination of ^3H on plates of Kieselgel G (0.25 mm) was carried out by continuous evaluation with a methane-flow counter. The over-all error was 10 to 30%, and yields on measuring ^3H, ^{55}Fe, and ^{14}C were compared. Some relationships between the amounts measured and the parameters of the measuring arrangement are presented. (Analytical Abstr.)

5792 DETERMINATION OF ^{89}Sr AND ^{90}Sr IN FOOD BY AN ALKALINE-EARTH-METAL SULFATE SEPARATION. Montag, A. (Nordrhein-Westfalen, Muenster, Ger.). Z. Lebensm.-Untersuch. Forsch., 127: 121-30(1965). (In German).

A procedure suitable for ash rich in Ca is described. ^{89}Sr and ^{90}Sr were precipitated from a solution of the ash in dilute HCl (with Sr and Ba carriers) by the addition of H_2SO_4 and ethanol, and Ca was then extracted from the precipitate by the addition of EDTA (Na salt) solution and adjustment of the pH to 4.5. The remaining precipitate was fused with K_2CO_3 plus Na_2CO_3, and the cooled melt, after being washed free from SO_4^{2-}, was dissolved in dilute HCl. After the removal of extraneous nuclides from this solution by scavenging with $FeCl_3$ and aqueous NH_3, the Ba was removed by precipitation as $BaCrO_4$, the Sr is then precipitated as $SrCO_3$. Directions are given for the measurement and calculation of the ^{89}Sr and ^{90}Sr in the final precipitate. A procedure is de-

scribed in which the ^{89}Sr and ^{90}Sr are precipitated (with carriers) from milk by the addition of oxalic acid; after treatment with fuming HNO_3, Ca is separated as described above. (Analytical Abstr.)

5793 ACCURATE ISOTOPE-DILUTION METHOD FOR MEASURING PLASMA FIBRINOGEN. Antencio, A. C.; Burdick, D. C.; Reeve, E. B. (Univ. of Colorado, Denver). J. Lab. Clin. Med., 66: No. 1, 137-45(1965).

Current methods of determining plasma fibrinogen require its separation by coagulation or precipitation. To avoid errors from incomplete separation and from occlusion of other proteins in the precipitate an isotope-dilution method was developed in which ^{131}I-labeled fibrinogen is added to plasma, the plasma fibrinogen is partially purified, then coagulated with thrombin, and the radioactivity and fibrin in the washed coagulin are determined. The wt of fibrin was obtained via UV absorption after dissolution of the fibrin in alkaline urea solution. Methods of preparing almost pure fibrinogen and labeling it with ^{131}I are described. The method has a coefficient of variation of 3.8%, and recovery experiments showed it to be satisfactory. (Analytical Abstr.)

5794 DETERMINATION OF THYROXINE BY COMPETITIVE PROTEIN-BINDING ANALYSIS EMPLOYING AN ANION-EXCHANGE RESIN AND RADIOACTIVE THYROXINE. Murphy, B. P. (McGill Univ., Montreal). J. Lab. Clin. Med., 66: No. 1, 161-7(1965).

Serum was deproteinised with ethanol, and an aliquot of the supernatant layer was evaporated to dryness. The residual thyroxine was equilibrated with ^{131}I-labeled thyroxine and thyroxine-binding globulin. Excess thyroxine was removed by shaking with an anion-exchange resin, and the bound thyroxine was calculated from the radioactivity of the supernatant layer. (Analytical Abstr.)

5795 UNIFORM NEUTRON IRRADIATION OF INHOMOGENEOUS SAMPLES. Priest, G. L.; Burns, Forrest C.; Priest, Homer F. (Army Materials Research Agency, Watertown, Mass.). Anal. Chem., 39: 110-13(Jan, 1967).

Various simple motions were studied singly and in combination to determine what motion or combination of motions would ensure not only uniform irradiation of both unknown and standard but also that both would receive an identical neutron dose for activation analysis. Two types of samples were considered: long, thin cylinders where radial effects are negligible, and disks where radial effects become important and longitudinal effects are minimized. Three methods were studied: a simulated planetary rotator identical to commercial units where the samples did not rotate on their own axes; and a parallel cylindrical rotator where samples were irradiated with rotation on their axes alone and in combination with traverse movement. Rotation and traverse rates were not found to be critical parameters. Tabulated data indicated uniform neutron irradiation of all samples using the parallel cylindrical rotator with both rotation and traverse movement. Positioning of the samples was not critical. (P.C.S.)

5796 DETECTION SENSITIVITIES IN NUCLEAR ACTIVATION WITH AN ISOTOPIC FAST-NEUTRON SOURCE. Wing, James; Wahlgren, M. A. (Argonne National Lab., Ill.). Anal. Chem., 39: 85-9(Jan, 1967).

Relative detection sensitivities of 73 chemical elements (all the radioactively stable elements except beryllium, lutetium, osmium, and the noble gases) were determined using a $^{241}Am-^{242}Cm-Be$ neutron source. The source provided a flux of 9×10^7 fast, unthermalized neutrons/cm^2-sec. The sensitivities were obtained for three experimental conditions: 5-min irradiation, 6-sec cooling, 2-min count; 5-min irradiation, 4.9-min cooling, 20-min count; and one-hr irradiation, one-hr cooling, 40-min count. The induced radioactivities were measured with a 10-cm by 10-cm NaI(Tl) crystal. The counts in the photopeaks, per gram of target element, are plotted vs the γ energies of the product nuclides. Self-absorption of neutrons and attenuation of γ rays in Teflon relative to aluminum were investigated. Reproducibility of the analytical method was 0.92%. (auth)

5797 DETERMINATION OF LANTHANIDE DISTRIBUTION IN ROCKS BY NEUTRON ACTIVATION AND DIRECT GAMMA COUNTING. Cobb, James C. (Brookhaven National Lab., Upton, N. Y.). Anal. Chem., 39: 127-31(Jan, 1967). (BNL-10370).

A method for analysis of 6 or 7 lanthanide elements in various rock types by activation analysis, followed by direct gamma counting of the sample, without chemical separations, on high-resolution lithium-drifted germanium semiconductor detectors is presented. La, Ce, Sm, Fu, Dy, Yb, Lu, Sc, and Pa were studied in samples that include most of the common rock types but only one mineral, garnet. Measurement procedures are discussed individually for La, Ce, Sm, Eu, Dy, Yt, and Lu. Abundances of Mn, Sc, and Th are considered as the chief interfering elements in the measurement of the lanthanides. (P.C.S.)

5798 SEPARATION OF ISOTOPIC INTERFERENCES UTILIZING Ge(Li) GAMMA-RAY DETECTORS. Parker, C. V. Jr.; Martin, T. C.; Morgan, I. L. (Texas Nuclear Corp., Austin). Trans. Amer. Nucl. Soc., 9: 599(Oct.-Nov. 1966).

5799 SENSITIVE AND ACCURATE ACTIVATION ANALYSIS METHOD FOR THE ROUTINE DETERMINATION OF FLUORINE. Graber, F. M.; Lukens, H. R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 590-1(Oct.-Nov. 1966).

5800 STUDYING THE EFFECTS OF TRACE ELEMENTS ON HIGH-PURITY LUBRICANTS USING ACTIVATION ANALYSIS. Jester, W. A.; Klaus, E. Erwin (Pennsylvania State Univ., University Park). Trans. Amer. Nucl. Soc., 9: 589-90(Oct.-Nov. 1966).

5801 FORENSIC ACTIVATION ANALYSIS: TRACE LEVEL ELEMENTS IN COMMERCIAL PAINTS. Bryan, D. E.; Guinn, V. P. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 589(Oct.-Nov. 1966).

5802 COMPUTER PROGRAM FOR IDENTIFICATION OF THE COMPONENTS OF COMPLEX GAMMA SPECTRA OBTAINED IN NEUTRON ACTIVATION ANALYSIS. Furr, A. K. (Virginia Polytechnic Inst., Blacksburg); Robins, C. H.; Robinson, E. L. Trans. Amer. Nucl. Soc., 9: 588-9(Oct.-Nov. 1966).

5803 NEUTRON ACTIVATION ANALYSIS WITH RESEARCH REACTORS. Guinn, Vincent P. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 588(Oct.-Nov. 1966).

5804 LIQUID SCINTILLATION COUNTING AT AMBIENT TEMPERATURE. Hall, T. C.; Weiser, C. J. (Univ. of Minnesota, St. Paul). Anal. Biochem., 17: 294-9(Nov. 1966).

Ambient-temperature liquid scintillation counting of aqueous samples of up to 2 ml volume realized efficiencies of over 80% for ^{14}C and 20% for ^3H in a dioxane-naphthalene scintillator. The use of external standardization for rapid determination of counting efficiency is presented together with some characteristics of a newly available commercial scintillation counter normally operated at room temperature. (auth)

5805 SEPARATION AND PURIFICATION OF CERIUM FROM EGYPTIAN MONAZITE SANDS. Saleh, F. A. (Atomic Energy Establishment, Cairo). Z. Anorg. Allg. Chem., 347: 205-14(Nov. 1966).

A process is described for the recovery of cerium from crude cerium(III) nitrate solution as sodium cerium sulfate. The double sulfate is then treated with 18% NaOH solution and dried at 110°C to hydrated ceric oxide. The purification of crude cerium by solvent extraction was studied and data are presented on the effects of several variables on the distribution coefficient of Ce(IV) between nitric acid and tributyl phosphate-kerosene. After extraction and scrubbing the cerium compounds obtained were found to be of spectroscopic purity grade. (auth)

5806 ESTIMATION OF URINARY OXALATE BY THE METHOD OF ISOTOPE DILUTION. Dean, B. M.; Griffin, W. J. (St. Bartholomew's Hospital, London). Nature, 205: 598-9(1965).

Urine (a 24-hr sample) was collected in 40 ml of 6N HCl, and, after the addition of [$^{14}C_2$] oxalic acid (1 μCi), concentrated HCl was added to make the mixture 2N in this acid. The solution was continuously extracted for 16 hr with peroxide-free ethyl ether, then the ether layer was evaporated in the presence of 5 ml of H_2O, and the aqueous residue was treated with 1 to 2 ml of aqueous NH_3 (d = 0.88) and saturated aqueous $CaCl_2$ (0.5 ml). The Ca oxalate was purified. Samples were counted by the liquid-scintillation technique with 100-μl aliquots from the HCl solution before the second precipitation. No quenching due to Ca oxalate was observed at the concentration used, and the counting efficiency was 51%. The purification process was repeated until the specific activity remained constant, and the amount of urinary Ca oxalate was calculated from its specific activity compared with that of a standard prepared from the same batch of [$^{14}C_2$] oxalic acid. The proposed method gave values for oxalate higher than those obtained by the method of Archer et al. (Clin. Sci., 16: 405(1957)); this is attributed to the superior sensitivity of the isotope dilution method. (Analytical Abstr.)

5807 THE RADIOACTIVATION ANALYSIS OF SEMICONDUCTOR GRAPHITE FOR NITROGEN BY THE $^{14}N(p,\alpha)^{11}C$ REACTION. Nozaki, Tadashi (Inst. of Physical and Chemical Research, Saitama, Japan); Okuo, Takayasu; Akutsu, Hiroyuki; Furukawa, Michiaki. Bull. Chem. Soc. Jap., 39: 2685-90(Dec. 1966).

The excitation curve for the $^{14}N(p,\alpha)^{11}C$ reaction was measured up to a proton energy of 15 MeV; the reaction was found to have a fairly high cross section for a sensitive determination of nitrogen

by radioactivation. A convenient technique was developed for the rapid quantitative conversion of the irradiated graphite into carbonate within a closed system. This technique makes possible the determination of a trace (down to several ppB) of nitrogen in pyrolytic graphite. Discussions of the possible interference (i.e., that of boron by the $^{11}B(p,n)^{11}C$ reaction) are also given. The nitrogen content of the pyrolytic graphite sample was found to vary markedly according to the starting material and to the preparation conditions. (auth)

5808 DETERMINATION OF TRACE AMOUNTS OF COPPER IN MILK BY NEUTRON ACTIVATION ANALYSIS. Samuelsson, Ernst-Gunnar (Dairy Inst., Alnarp, Sweden). Milchwissenschaft, 21: 31-5(Jan. 1966).

A technique was developed for determination of Cu in milk by neutron activation analysis. The dried milk sample (0.25 g) was irradiated in a thermal neutron flux of about 1.4×10^{12} n/cm^2 sec. After addition of carrier, and wet ashing with H_2SO_4 and a small amount of H_2O_2, the sample was freed from other nuclides by a newly devised ion-exchange technique. The radioactivity was determined as the 0.51-MeV peak. The chemical yield from this analysis is also determined by addition of tetraethylenepentamine (TEPA) which gives a blue color with Cu, maximum at 635 mμ, in alkaline solution. The activation analysis can consequently be corrected for losses during the analysis. The standard error of the mean is calculated to ±0.0005 ppM. Sensitivity can be increased by increasing the amount of milk. Slight modifications of this method readily provide a method for determination of the content of several other metals. (BBB)

5809 LIQUID SCINTILLATION COUNTING OF ^3H AND ^{14}C COMPOUNDS IN ANIMAL TISSUES. Eldefrawi, M. E. (Cornell Univ., Ithaca, N. Y.). Anal. Biochem., 17: 353-5(Nov. 1966).

A procedure using nitric acid for tissue digestion is described, which gives a high counting efficiency for tritium and ^{14}C water-soluble nonvolatile compounds. This technique was applied to small pieces of different tissues from the rat and the American cockroach, including the rat skin and roach cuticle. The counting efficiency for tritium ranged from 9.3 to 11% compared to 12.5% for counting tritium standards in Bray's dioxane cocktail, and was 60% for ^{14}C, which is the maximum efficiency obtained with ^{14}C in this cocktail. Increasing the amount of rat brain and roach muscle hardly affected the counting efficiency of ^{14}C but tritium counting efficiency was reduced by increasing the amount of tissue. (D.H.M.)

5810 URANIUM MICROMAPS: TECHNIQUE FOR IN SITU MAPPING OF DISTRIBUTIONS OF FISSIONABLE IMPURITIES. Fleischer, Robert L. (California Inst. of Tech., Pasadena). Rev. Sci. Instrum., 37: 1738-9(Dec. 1966).

A method of in situ mapping, which leaves a transparent map overlay on the mapped material thus allowing the specific locations of uranium (or other fissionable element) to be identified, is described. The method involved placing, keeping in place during irradiation, and etching a thin film detector. For such a thin detector (defined as having a thickness less than the length of the tracks produced by the fission fragments involved) chemical development of tracks was possible by treatment of the side of the film away from the mapped surface. A thin film of Makrofol polycarbonate was pressed against the surface of the sample. A solvent cast detector was used to seal the edges of the thin detector and a material low in U relative to the material to be examined was used as a protective cover during neutron irradiation. In calculating the uranium content from the track density an extra etching efficiency factor entered the usual equation. This factor arose because a portion of the tracks that extended into the detector from the sample did not cross to the etched surface and hence was not revealed. The technique can be used to observe U concentrations ranging from unity down to 10^{-11}. Other fissionable heavy isotopes such as thorium, plutonium, and neptunium can be examined by the technique. Elements undergoing (n,α) reactions such as boron or lithium could be examined by using an α-sensitive track detector such as cellulose nitrate. (D.H.M.)

5811 NEUTRON ACTIVATION ANALYSIS OF THORIUM IN NATURAL WATERS. Osawa, Masumi; Tokunaga, Okihiro (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 3: 333-42(Aug. 1966).

Neutron activation analysis of Th in mineral springs and coastal waters is reported. After preliminary concentration of Th in natural waters with coprecipitation of ferric hydroxide, the samples were irradiated in JRR-2. The ^{233}Pa produced in the target materials was radiochemically separated by solvent extraction using a hydrochloric acid system, and the electrodeposited source was counted. The chemical yield was verified by ^{231}Pa tracer. The reliability of this method was ascertained by the use of standard rock G-1. Values of 0.01 to 0.5 μg/l were obtained for Th content in waters from several springs in Japan. These values were much lower than those previously reported, and the characteristics varying with region are reported. Some geochemical considerations with regard to the origin of U in the springs of such localities as Asanbara and Misasa are discussed. (NSA of Japan)

5812 DETERMINATION OF HEXAMMINECOBALT(III)-, MONOCHLOROPENTAMMINECOBALT(III)-, AND COBALT(II)-IONS IN THEIR MIXTURE BY THE ISOTOPE DILUTION METHOD. Ikeda, Nagao; Muto, Haruo (Tokyo Univ.). Radioisotopes (Tokyo), 15: 165-8(July 1966).

A simple and rapid method was investigated for the determination of $[Co(NH_3)_6]^{3+}$, $[Co(NH_3)_5Cl]^{2+}$ and Co^{2+} ions in their mixture by the aid of the direct isotope dilution method. $[Co(NH_3)_6]^{3+}$ ion was separated in the form of $[Co(NH_3)_6]Cl_3 \cdot 2CdCl_2 \cdot 3H_2O$ by treating with the equal volume of 10% $CdCl_2$ solution. $[Co(NH_3)_5Cl]^{2+}$ ion was separated in the form of the $[Co(NH_3)_5Cl]Cl_2$ precipitate by adding conc. HCl to 1.5N. Co^{2+} ion was separated from the cation-exchanger bed column by eluting with 1N HCl. The determinations of several to several tens mg of these ions are possible within ±3% error. The simple procedures for the preparation of ^{60}Co-labeled $[Co^*(NH_3)_6]Cl_3$ and $[Co^*(NH_3)_5Cl]Cl_2$ by the radiosynthetic method are also given. (auth)

5813 CARBON DIOXIDE AS CARRIER GAS IN GASEOUS RADIOCHROMATOGRAPHY. Forys, M. S. Radiokhimiya, 8: 115-18(1966). (In Russian).

An installation for gaseous radiochromatography using carbon dioxide as carrier gas and counting gas was developed. The basic characteristics of the installation are given. Examples of the radiochromatographic determination of compounds, labeled with ^{14}C, are reported. (tr-auth)

5814 DETERMINATION OF THE EQUIVALENCE POINTS AND SOLUBILITY PRODUCTS IN RADIOMETRIC AND SIMILAR PRECIPITATION TITRATION. Klas, J. (Slowakische Technische Hochschule, Bratislava). Collect. Czech. Chem. Commun., 31: 3512-18(Sept. 1966). (In German).

A method for the equivalence point determination in precipitation titrations is proposed. The method has no errors caused by the solubility of the precipitate so that it can be used in titrations of very dilute solutions. The equivalence point can be calculated from two points of the linearized titration curve and these data can be used for determining the solubility products of the precipitates. The method can be used in radiometric and similar titrations, when the reaction proceeds according to the equation A + B = AB and when the ion to be titrated is active. (tr-auth)

5815 SYSTEMATIC ERRORS IN RADIOMETRIC AND SIMILAR PRECIPITATION TITRATIONS. Klas, J. (Slowakische Technische Hochschule, Bratislava). Collect. Czech. Chem. Commun., 31: 3519-28(Sept. 1966). (In German).

The systematic errors arising in the titration of radiometric and similar precipitation titrations because of precipitate solubility and dilution of the solution to be titrated with the titrating medium were investigated. The equation for the errors of some currently used methods for determining the titrant were derived when the precipitation proceeds according to the equation A + B = AB and when the ion to be titrated is active. Tables of the calculated errors are given as examples for application of the equations derived. (tr-auth)

5816 SMALL MASS SPECTROMETER AS A SUBSTANCE-SPECIFIC DETECTOR FOR GAS CHROMATOGRAPHS. Brunnee, C.; Delgmann, L. (Fried. Krupp Mess- und Analysentechnik, Bremen). Chem.-Ingr.-Tech., 38: 730-3(July 1966). (In German).

A small 180° mass spectrometer for specific analysis of gas chromatographic effluents is described. Three detectors are employed: one in the source as total ion monitor, one at radius 2 cm for analysis of m/e 2 to 12, and one at radius 5 cm for analysis of m/e 12 to 300. The induction of the permanent magnet is 3800 G, and accelerating voltages between 60 and 1500 V are used. Slit widths (in the source), resolution (10% valley), and sensitivity to partial pressure are related as follows: 0.25 mm, 50, 2×10^{-4} A/torr; 0.15, 80, 1×10^{-4} A/torr; 0.06, 120, 3×10^{-5} A/torr. The electronics, pumping, and inlet system are described briefly. Coupling to the gas chromatograph occurs via a stream splitter (1:1, half of which is analyzed by flame ionization) and a capillary system (0.25 mm ID, then 1 μm ID) so that the stream is admitted to the source at 3×10^{-4} torr. Examples of analysis of small amounts of methanol and ethyl ether in hydrocarbons by use of the m/e 31 peak, and analysis of trimethyl silyl ethers in complex mixtures by the m/e 75 peak, are given. (BBB)

5817 INSTRUMENT FOR LUNAR SURFACE CHEMICAL ANALYSIS. Turkevich, Anthony (Univ. of Chicago); Knolle, Karlfried; Emmert, Richard A.; Anderson, Wayne A.; Patterson, James H.; Franzgrote, Ernest. Rev. Sci. Instrum., 37: 1681-6(Dec. 1966).

An instrument was designed and constructed that utilizes the interactions of monoenergetic alpha particles with matter for surface chemical analysis. The source of alpha particles is a radioactive nuclide, such as ^{242}Cm. The energy spectra of backscattered alpha particles are measured with semiconductor detectors. Other detectors (with gold foils over them to eliminate alpha particles) register protons from α,p reactions. Transistorized electronics provide 128-channel pulse height analyzers for both alpha and proton spectra. The first prototype instrument designed for the planned Surveyor Lunar Missions weighs less than 4 kg and uses less than 1.3 W. (auth)

5818 THE STUDY OF THE DECONTAMINATION OF RADIOACTIVE SOLUTIONS WHICH CONTAIN ^{90}Sr USING ION EXCHANGERS. Lambrino, Vl. (Institut de Medecine et de Pharmacie, Bucharest). Compt. Rend. Acad. Bulg. Sci., 19: 487-90 (1966). (In French).

The decontamination capacity of aluminosilicate ion exchangers for the elimination of ^{90}Sr from solutions was studied. The degree of decontamination was determined by a dynamic method (filtration using a filtration column) and a static method (time of contact) as a function of time of the quantity of aluminosilicates used. The dynamic method showed that the degree of decontamination began with a sharp increase so that after 10 minutes of filtration, the decontamination attained values between 80 and 90%, with a maximum of 92%. The results obtained by the static method showed that the degree of decontamination was proportional to the contact time and to the quantity of aluminosilicate used. (J.S.R.)

5819 USE OF SYNTHETIC INORGANIC ION EXCHANGERS FOR THE SEPARATION OF CALCIUM AND SCANDIUM. Zsinka, Laszlo; Szirtes, Laszlo. Magyar Kem. Lapja, 21: 536-8(Oct. 1966). (In Hungarian).

Studies showed that due to their resistance against ionizing radiation synthetic inorganic ion exchangers can be successfully used in radiochemical practice. The time necessary for attaining equilibrium increases with higher ion valencies and with decreasing concentration. The capacity values increase with decreasing ionic radii. It is concluded that the exchangeable ions are provided by the hydrogen ions used during the dissociation of $ZrPO_4$ (ZP). The selectivity factor α^{Sc}_{Ca} (ZP) increases with decreasing pH values. In such a manner the separation of the system Ca–Sc can be adequately performed. (auth)

5820 VOLUMETRIC DETERMINATION OF Ce(III) WITH $K_4Fe(CN)_6$ IN PRESENCE OF 3,3'-DIMETHYLNAPHTIDINE. Basinska, Halina (Copernicus Univ., Torun, Poland); Soboczynska, Janina. Chem. Anal. (Warsaw), 11: 989-94(1966). (In Polish).

A method is described for the direct determination of Ce(III) by titration with potassium ferrocyanide solution in water–ethanol medium using 3,3'-dimethylnaphthidine as redox indicator. The titration was carried out at pH 5 to 6 in acetate buffer. At the equivalence point a sharp change of the solution color from dark pink to green occurred. The determination required about 15 min. The procedure can be applied for the samples containing from 0.03 to 0.6 g of cerium. The presence of Mg, Ca^{2+}, Cr^{3+}, Cl^-, NO_3^-, SO_4^{2-}, CH_3COO^- did not interfere. However, Fe^{3+}, Cu^{2+}, Zr^{4+}, and Th^{4+} should be removed by extraction of their cupferronates from a strongly acidic medium. Cerium ions should be separated from Zn^{2+} by precipitation with ammonia. Anions which complex or precipitate cerium ions interfered. The error of determination was less than 1% as compared with results obtained by the gravimetric method. (auth)

5821 CONTROLLED-ATMOSPHERE DC ARC FOR THE QUANTITATIVE DETERMINATION OF RARE EARTHS IN CALCIUM FLUORIDE. Nash, D. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Appl. Spectros., 20: 392-4(Nov.-Dec. 1966).

Optimum controlled-atmosphere conditions for the determination of rare earths in calcium fluoride were investigated. The specific technique evolved for terbium and holmium is described. The limits of detection and precision of the method are given. (auth)

5822 ANALYSIS AND CONTROL OF RADIOACTIVE STANDARDS BY USING BETA AND GAMMA SPECTROMETRY. Legrand, J.; Brethon, J. P.; Fraisse, J.; Boulanger, J. P. (CEN de Saclay, Gif-sur-Yvette, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/45, 34p. (In French). (CONF-661012-18). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

The following analytical techniques employed to determine the radiochemical and radioisotopic purity of the products used as radioactive standards are described: gamma spectrometry using scintillation counters, beta and gamma spectrometry using semiconductor detectors (silicon and germanium), and control using a two-parameter analysis circuit. The data obtained for each of these techniques are processed on a computer. Special methods of calculation and programs were developed, e.g., a least-squares method for complex mixtures, and a method of representing total absorption peaks by mathematical functions for finding the areas and separating peaks that are very close together. Precise examples are given for each of the analytical techniques, together with the minimum detectable contents. A number of special cases are studied in greater detail: measurement of ^{199}Au in ^{198}Au, where the content varies according to the irradiation conditions, and analysis of the mixture $^{95}Zr + {}^{95}Nb$ and determination of traces of one in the other. It is possible to measure several parts per thousand of ^{95}Zr in ^{95}Nb and vice versa using gamma spectrometry by means of lithium-drifted germanium detectors. (auth)

5823 METHODS OF RADIOACTIVITY METROLOGY IN THE USSR. Karavaev, F. M.; Konstantinov, A. A.; Kholnova, E. A. (Mendeleev All-Union Scientific Research Inst. of Metrology, Leningrad). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/68, 16p. (In Russian). (CONF-661012-12). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

Methods and apparatus presently used in Soviet metrology laboratories for accurately measuring the specific activity of reference radionuclide solutions and the activity of radioactive sources of different types are reviewed. The primary standards made and used at the Mendeleev Institute of Metrology for reproducing the activity unit of radionuclides (natural and artificial) in radioactive sources over a wide range of activity unit values and for different kinds of radioactive decay: assemblies with 4π counters of different dimensions, an assembly for counting $4\pi\beta$-γ and β-γ coincidences, and assemblies with gamma calorimeters (of the static and adiabatic types) and ionization chambers are described. The methods and apparatus for transferring the measurement of the activity unit from the standards to the radioactive sources and measuring instruments (alpha and beta radiation meters) used in practice, control units, measuring techniques, and reference alpha, beta, and gamma sources, are described. The control circuit that regulates the order in which the transfer is effected is also discussed. (auth)

5824 MICRO-WEIGHING IN ACTIVITY MEASUREMENTS. Le Gallic, Y.; Grinberg, B.; Thenard, M. (CEN de Saclay, Gif-sur-Yvette, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/41, 32p. (In French). (CONF-661012-16). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

With a view to ensuring maximum weighing accuracy a comparative study was made of different types of micro-balance; the study made it possible to determine under what conditions these balances should be used. Particular attention was paid to studying and explaining the role of various factors (hygrometric degree, temperature, etc.) on which the precision of simple differential weighing depends. This study shows the importance of inaccuracies in the weights and the advantages of operating exclusively in the optical-scale range. Sources of mass from 10 to 15 mg were used for analysis of the different factors to be taken into consideration as affecting the final accuracy of the activity measurement: weighing accuracy, dilution factor, and upper limit of source diameter (minimization of self-absorption). A comparison was made between the different methods of aliquot sampling (pycnometer, evaporation, etc.) with account being taken of the many parameters, such as evaporation, absorption, temperature gradient, etc., that may reduce the accuracy in determination of this optimal mass. The accuracy for the mass of a microdrop is at best 0.1%, so that it constitutes an important part of the error in determining the activity of radioactive solutions. (auth)

5825 TRACER METHODS FOR CALIBRATING ^{55}Fe. Petel, M.; Houtermans, H. (International Atomic Energy Agency, Vienna). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/63, 16p. (In French). (CONF-661012-21). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

A coincidence device, consisting of a 2 π proportional counter operating under argon-methane pressure and a NaI crystal, was used to study two tracer methods, one of which employs ^{54}Mn and the other ^{55}Fe. A known mass of a solution of ^{54}Mn, previously calibrated, was mixed with a known mass of the ^{55}Fe solution to be measured. The mixture was counted by coincidences between the x rays of $^{55}Fe + {}^{54}Mn$ and the γ rays of ^{54}Mn. Using the constant $P_k\omega_k$ of ^{54}Mn, the self-absorption Y_M due to the ^{54}Mn was determined by calculating the C/B ratio (coincidence rate to γ rate). Using different sources the content of carrier in the Mn was varied and the function $N/m_F = F(Y_M)$ plotted on a graph (N/m_F

is the count rate per unit mass of ^{55}Fe solution). The straight line obtained was extrapolated to $Y_M = 0$. Electrolytic sources and weighed sources were prepared from a mixture of ^{59}Fe and ^{55}Fe. ^{59}Fe was used to determine the equivalent mass of the electrolytic sources. The measurements were made simultaneously in a γ detector of high stability and in a proportional counter for x rays. Corrections were made for the β-γ effect of ^{59}Fe in the counter. The count rate of the ^{55}Fe solution was thus obtained per unit mass. The two methods were cross-checked against each other with an uncertainty of the order of 1.5%. (auth)

5826 CALIBRATION OF ^{103m}Rh BY COINCIDENCE METHOD. Vuorinen, Antti (International Atomic Energy Agency, Vienna). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/64, 12p. (CONF-661012-28). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

The relative activity determination of ^{103}Rh is based on measurement of the 20-keV x ray with a thin NaI crystal. The uncertainties in disintegration parameters made an absolute calibration necessary. The absolute activity of thin electrolytic source sources was measured with a $4\pi\beta$-X coincidence counting system in which efficiencies of more than 95% were obtained. These calibrated sources were used in calibration of an x-ray counting arrangement. (auth)

5827 STANDARDIZATION OF ^{230}Th BY FILTER-PAPER LIQUID SCINTILLATION COUNTING. Schaerf, K. (International Atomic Energy Agency, Vienna). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/59, 6p. (CONF-661012-24). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

The calibration of α-emitters can be done with an accuracy of ±1% by α-γ (x) coincidence counting if γ or x rays are emitted in cascade with at least one α group. This type of calibration is normally made with a 4π proportional counter and an NaI(Tl) crystal; 4π efficiencies of more than 99% can be expected. But in the case of solutions with very high carrier concentrations, e.g., very long-lived nuclides, the 4π efficiency may be very low (<25%). For these nuclides, scintillation counting of sources on filter paper soaked with the scintillator, as described by Brinkman (1961), is a very convenient method. Results of a calibration of ^{230}Th are reported. Coincidence counting was used with a 2-mm NaI crystal (Be-window) for the detection of the L x rays. Efficiencies well above 90% were obtained. (auth)

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Refer also to abstracts 5747, 5959, 6026, 6764, 7857, and 7885.

5828 (ANL-7240) LABORATORY INVESTIGATIONS IN SUPPORT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART XIII. CONDENSED-PHASE EQUILIBRIA IN THE SYSTEM MOLYBDENUM HEXAFLUORIDE–URANIUM HEXAFLUORIDE. Trevorrow, L. E.; Steindler, M. J.; Steidl, D. V.; Savage, J. T. (Argonne National Lab., Ill.). Aug. 1966. Contract W-31-109-eng-38. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Condensed-phase equilibria in the system MoF_6–UF_6 were studied by thermal analysis and x-ray diffraction. The temperature-composition phase diagram constructed from observed thermal arrests is characteristic of a binary system forming solid solutions, a minimum-melting mixture (22 mole % UF_6 at 13.7°C), and a solid-miscibility gap. The diagram shows that the maximum solid solubility of the smaller MoF_6 molecule in the UF_6 lattice is about 30 mole % MoF_6, while the maximum solid solubility of the larger UF_6 molecule in the MoF_6 lattice is 12 to 18 mole % UF_6. The temperature of the solid-state transformation of MoF_6 increases from ~–10°C in pure MoF_6 to ~–5°C in mixtures with UF_6, indicating that the solid solubility of UF_6 is greater in the low-temperature form of MoF_6 than in the high-temperature form of MoF_6. This solid-solubility relationship can be expected in view of the crystal structures of the pure components. The x-ray diffraction pattern of the high-temperature form of pure MoF_6 can be indexed as a body-centered-cubic structure; the x-ray pattern of the low-temperature form of pure MoF_6 can be indexed as an orthorhombic structure, similar to (but not necessarily identical to) the orthorhombic structure of UF_6. (auth)

5829 (AWRE-O-93/66) EXCHANGE OF HYDROGEN ISOTOPES BETWEEN METHANE AND ERBIUM TRITIDE. Jones, P. M. S.; Ellis, P.; Hutcheson, C. G. (Atomic Weapons Research Establishment, Aldermaston (England)). Nov. 1966. 14p. Dep. mn. BIS $0.50. HMSO 2s. 6d.

The exchange of gaseous methane with an erbium tritide film was studied. The kinetics show that the rate-controlling step in the reaction was the rate of production of atomic hydrogen by methane radiolysis, primarily by gas phase tritium. Molecular hydrogen exchanged much more slowly than methane. (auth)

5830 (BNWL-SA-734) ON THE NATURE OF THE AMERICIUM–OXYGEN SYSTEM: DISSOCIATION PRESSURES, RELATED THERMODYNAMIC FUNCTIONS, AND PHASE EQUILIBRIA. Chikalla, Thomas David (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1966. Contract AT(45-1)-1830. 180p. (BNWL-CC-828). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Wisconsin Univ., Madison.

An isopiestic–thermogravimetric technique was used to measure the oxygen dissociation pressures over substoichiometric americium oxides at 866 to 1172°C and from one to below 10^{-6} atm O_2. The nonstoichiometric compositions encountered under these conditions covered the interval $1.80 < O/Am < 2.00$. The relative partial molar enthalpy and entropy of solution in oxygen in AmO_{2-x}, calculated from the experimental dissociation pressures, were found to be a function of composition, but independent of temperature in the region studied. A sharp change in slope on both the $\Delta\bar{H}$ (O_2) and $\Delta\bar{S}$ (O_2) versus composition plots occurred at about $AmO_{1.98}$. Phase relations in the system between $1.50 < O/Am < 2.00$ were studied using Guinier and Debye diffraction methods on quenched and annealed samples. The cubic Am_2O_3 phase was found to be capable of dissolving excess oxygen and existed as a defect phase over the broad interval of about $1.51 < O/Am < 1.72$. Between $AmO_{1.72}$ and $AmO_{1.90}$ the system was diphasic and consisted of these two phases. Evidence was found for what is believed to be a new Am_2O_3 phase, which is probably monoclinic (B-type rare earth sesquioxide structure). The likelihood for existence of this phase, as well as the cubic and hexagonal Am_2O_3 phases, is discussed in terms of a rare earth/actinide oxide analogy based on considerations of ionic radii. A homologous series of substoichiometric ordered intermediate phases was looked for, but not observed. The lack of such phases in this system is thought to be the result of self-induced radiation damage caused by the alpha decay of ^{241}Am. The dependence of the weight change accompanying nonstoichiometry on the exponent of the oxygen pressure was used to consider possibilities for the defect structure of AmO_{2-x}. (auth)

5831 (CEA-R-3079) CINETIQUE DES REACTIONS D'OXYDO–REDUCTION DES ELEMENTS TRANSURANIENS EN SOLUTION. (Kinetics of Transuranium Element Oxidation–Reduction Reactions in Solution). Gourisse, Daniel (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Sept. 1966. 56p. (In French). Dep. mn.

Thesis. Submitted to Paris Univ. (France). Faculte des Sciences.

A systematic review of the kinetics of oxidation-reduction reactions of the elements U, Np, and Am in perchlorate solution is proposed. Some considerations relative to the thermodynamic values of activation associated with elementary behavior (effect of compensation, standard entropy of active complexes, reaction velocity) are developed. The influence of acidity, ionic strength, heavy water, and the polarity of mixed solvents on the speed of reactions is described. Finally, the influence of different anions on the velocity of reactions is explained by the variations in the free standard enthalpy of the reaction and by the variations in the free enthalpy of activation (work of electrostatic forces) resulting from the complexing of species dissolved in the solution. (tr-auth)

5832 (COO-522-14) SPECIFIC HEAT DETERMINATIONS OF PURE, SOLID PARA DEUTERIUM. Final Report, April 1, 1957–August 31, 1966. White, David (Ohio State Univ. Research Foundation, Columbus). Nov. 29, 1966. Contract AT(11-1)-522. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

During the process of measuring heat capacity of ortho–para mixtures of solid deuterium, studies were also made on the ortho–para separation process on terms of some simple models describing the interaction of a diatomic molecule with a solid surface, and the separation of molecular hydrogens by spontaneous phase separation of liquid or solid solutions. The completion of heat capacity studies of ortho–para mixture of solid deuterium verified that the anisotropic (rotationally dependent) interactions of the diatomic molecules in the solid were principally quadrupolar and also strongly suggested that the crystal structure both above and below the λ-anomaly needed clarification. (P.C.H.)

5833 (HW-51937) PLUTONIUM METAL DISSOLUTION. PART II. Ketzlach, N. (General Electric Co., Richland,

Wash. Hanford Atomic Products Operation). Aug. 14, 1957. Contract AT(45-1)-1350. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A study was made of the nuclear safety involved in the dissolution of plutonium metal. The study indicated that the minimum critical mass of a plutonium metal–plutonium solution system may be no less than that for the plutonium metal–water system or homogeneous solution system, whichever is smaller. The enriched uranium metal–uranium solution system was also studied. Experiments are suggested to verify the results. (M.C.G.)

5834 (IA-1082, pp 77-202) CHEMISTRY. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

Developments are reported for studies on inorganic and physical, radiation, nuclear, analytical, and biochemistry. (P.C.H.)

5835 (IA-1091) ENERGY DISTRIBUTION OF ENERGETIC ATOMS IN A GASEOUS MEDIUM. I. ELASTIC SCATTERING OF PARTICLES BY SPHERICAL POTENTIALS OF THE FORM $V(r) = A_1/r^{S_1} + A_2/r^{S_2}$. Baer, M.; Amiel, S. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). June 1966. 36p. Dep. mn.

The energy distribution function n(E) for energetic particles in a gaseous medium is treated (classically) assuming elastic scattering governed by a two-term spherical potential of the form $V(r) = A_1/r^{S_1} + A_2/r^{S_2}$. It was found that in the energy interval from 1 MeV to 1 keV, n(E) differs from that computed for a single-term potential, but it makes almost no difference whether the second (long range) component is of an attractive or repulsive nature. In the low energy range (<1 keV), if the long range component is repulsive it almost completely screens the short range one (which is always assumed to be repulsive). If it is attractive it lowers the values of n(E) in comparison with those obtained with a repulsive long range term. The calculations also show that n(E) is almost independent of the initial energy of the incoming particles. The results can be applied to the calculation of the yields of chemical reactions caused by energetic atoms such as fission fragments. One of the implications which emerges is that the yields of the reactions would not be influenced by the initial spectrum of the energetic atoms, since this has practically no effect on n(E) provided that the atoms behave like material points. (auth)

5836 (JEN-166-DMa/I-20) DENSIDADES-CONCENTRACIONES DE SOLUCIONES ACUOSAS DE NITRATO DE URANILO. (Densities-Concentrations of Aqueous of Uranyl Nitrate Solutions). Rodrigo Otero, A.; Rodriguez Hernandez, B.; Fernandez Rodriguez, L. (Junta de Energia Nuclear, Madrid (Spain). Division de Materiales). 1966. 19p. (In Spanish). Dep. mn.

The density–concentration ratios of aqueous uranyl nitrate solutions expressed as U_3O_8 grams/liter, U grams/liter, and hexahydrated uranyl nitrate wt % at different temperatures, were established. Experimental values are graphically correlated and compared with some published data. (auth)

5837 (JUL-Bibl.-11) KRYPTON PHYSIKALISCHE UND PHYSIKALISCH-CHEMISCHE EIGENSCHAFTEN. EINE LITERATURZUSAMMENSTELLUNG. (Krypton Physical and Physicochemical Characteristics. A Bibliography). Paul, E.; Gehrke, G. (Kernforschunsanlage, Juelich (West Germany)). Sept. 1966. 20p. (In German and English). Dep. mn.

Two hundred and nine references are presented covering the period 1940 to 1966. They are arranged under the following headings: general, thermodynamics, transport characteristics, exchange action of krypton with solids, solubility of krypton in fluids, solid krypton, physical properties, and production and use of krypton. An author index is included. (M.C.G.)

5838 (KAPL-M-6564) EXPLOSION AND DETONATION LIMITS FOR AN OXYGEN–HYDROGEN–WATER–VAPOR SYSTEM. Mathews, R. L. (Knolls Atomic Power Lab., Schenectady, N. Y.). June 1966. Contract W-31-109-eng-52. 54p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A conservative set of limits for the allowable oxygen concentration in an oxygen–hydrogen–water vapor system as a function of various temperatures and water vapor conditions is defined and evaluated. The oxygen limits are expressed for both superheated vapor conditions and for isothermal temperature conditions. The oxygen limits are based on the assumption that the steam–gas mixture will not be combustible as long as the energy release from the complete combustion of the oxygen is not sufficient to raise the temperature of the mixture to 1000°F in a constant pressure process. Calculations are presented for detonation limits according to the Belles detonation theory. Since the calculated temperatures for cases with appreciable water vapor are exceedingly high, it appears that some of the slower radical reactions which are neglected in the Belles theory may become important. In order to provide a very conservative limit for the oxygen concentration which could cause detonation, the Belles theory is extended to include predictions based on the reactions proposed by Lewis and von Elbe for the third autoignition limit. (auth)

5839 (LA-3562) DISTRIBUTION OF AMERICIUM BETWEEN LIQUID PLUTONIUM AND A FUSED SALT. EVIDENCE FOR DIVALENT AMERICIUM. Mullins, L. J.; Beaumont, A. J.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). May 17, 1966. Contract W-7405-eng-36. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The distribution of Am between liquid Pu metal and a fused salt of NaCl–KCl containing $PuCl_3$ has been studied at 698, 730, and 775°C over a $PuCl_3$ mole fraction range of 6×10^{-3} to 2×10^{-2}. The distribution data are consistent with the following equation: Am (l) + (2/3)$PuCl_3$ (l) = (2/3)Pu (l) + $AmCl_2$ (l). From the temperature dependence of the equilibrium constant, a value of −3.5 kcal was obtained for $\Delta H°$ for the above reaction. (auth)

5840 (LA-3579) FREEZING POINTS OF SOME TERNARY MIXTURES DERIVED FROM 55 MOLE PERCENT UCl_3–45 MOLE PERCENT KCl. Thamer, B. J. (Los Alamos Scientific Lab., N. Mex.). Sept. 21, 1966. Contract W-7405-eng-36. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Differential thermal analysis was used to locate high-uranium, low-freezing compositions in some ternary fused salts containing UCl_3 and KCl. Evidence is presented for the following ternary eutectics (mole %): 5.0 UF_3–50.8 UCl_3–44.2 KCl, 518°C; 5.0 UF_4–48.5 UCl_3–46.5 KCl, 499°C; 46 LiCl–30 UCl_3–24 KCl, 418°C; 35 NaCl–35 UCl_3–30 KCl, 510°C; and 27 $MgCl_2$–25 UCl_3–48 KCl, 447°C. The applicability of these mixtures to a molten blanket for a fast reactor is discussed. (auth)

5841 (LA-DC-8300) A PARAMETRIC STUDY OF FLASH THERMAL DIFFUSIVITY MEASUREMENTS. Morrison, B. H.; Klein, D. J.; Cowder, L. R. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 26p. (CONF-661032-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 6th Conference on Thermal Conductivity, Dayton, Ohio.

Assumptions made in a particular solution of the general Fourier heat flow equation were critically examined and verified by thermal diffusivity measurements on Armco iron. Two modifications of the flash technique were used to measure the thermal diffusivities of two types of Armco iron in several geometries; the data are reported over the −180 to 300°C temperature range. A ruby laser system and a helical flash tube were used as pulsed energy sources; chromel–constantan thermocouples detected the transient time–temperature response of the heat pulse through the sample. This transient current was amplified and displayed on a cathode ray tube, photographed, and converted to a value for thermal diffusivity by the expression $\alpha = (\omega l^2/t_x)$. (auth)

5842 (N-66-32390) HEATS AND FREE ENERGIES OF FORMATION OF ANHYDROUS CARBONATES OF BARIUM, STRONTIUM, AND LEAD. Adami, L. H.; Conway, K. C. (Bureau of Mines, Berkeley, Calif.). 1966. 12p. (BM-RI-6822).

The heats of formation of anhydrous barium carbonate (witherite), strontium carbonate (strontianite), and lead carbonate (cerussite) were determined by solution calorimetry. The solution mediums were hydrochloric acid for barium and strontium carbonates and perchloric acid for lead carbonate. The heats of formation at 298.15°K are as follows: $BaCO_3$, −297.5 ± 0.8 kcal/mole; $SrCO_3$, −294.6 ± 0.5 kcal/mole; and $PbCO_3$, −168.0 ± 0.3 kcal/mole. (auth)

5843 (ORNL-P-1771) ErO(OH): A MONOCLINIC LANTHANIDE OXYHYDROXIDE. Kopp, O. C.; Harris, L. A. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Single crystals of hydrothermally synthesized ErO(OH) have monoclinic symmetry. Previously, related lanthanide oxyhydroxides of Yb and Eu were considered to be orthorhombic, based on powder diffraction data. The unit cell has dimensions: $\underline{a}_0 = 4.299 \pm 0.005$, $\underline{b}_0 = 3.601 \pm 0.002$, and $\underline{c}_0 = 11.225 \pm 0.005$ Å, and $\beta = 92°08' \pm 0°06'$. Twinning is common with (001) as both the twin and composition planes. Chemical, physical and optical data are presented. (auth)

5844 (ORNL-TM-1682) ANALYSIS AND SIGNIFICANCE OF RARE-EARTH OXIDES PRODUCED BY A SOL–GEL METHOD. Buxton, S. R.; Hardy, C. J.; Lloyd, M. H. (Oak Ridge National Lab., Tenn.). Sept. 7, 1966. Contract W-7405-eng-26. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Rare earth oxides have been prepared by a sol-gel method and their microstructure examined at various stages by metallography, electron microscopy, and x-ray spectroscopy. A rare earth hydroxide sol is prepared from the nitrate, dehydrated to a gel, and this is calcined to dense oxide at relatively low temperature under conditions which depend on the crystal form and properties required, e.g., cubic europium oxide at 1000°C, mono-

clinic europium oxide at 1475°C. Uses for these oxides are discussed. (P.C.H.)

5845 (ORNL-TM-1716) LABORATORY STUDIES OF THE ELECTROLYSIS OF WATER. THE FEASIBILITY OF ELECTROLYSIS AT TEMPERATURES TO 400 DEG F. Mrochek, J. E.; Kibbey, A. H. (Oak Ridge National Lab., Tenn.). Dec. 7, 1966. Contract W-7405-eng-26. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The electrolysis of water was studied at ORNL by using a cell consisting of two porous nickel electrodes and a thin membrane. Attempts to reduce the oxygen overvoltage in this cell by electrolytically depositing ^{63}Ni on a porous nickel substrate and using it as the anode yielded inconsistent results. A sine-wave commutator used for measuring IR-free cell voltage and voltage drop resulting from the internal resistance of the cell was found to provide only qualitative information. The feasibility of high-temperature (greater than 250°F) electrolysis, which was examined from the standpoint of recent literature on fuel cell technology, particularly the performance of membranes at high temperatures, appears promising. (auth)

5846 (SC-TM-66-428) PHYSICAL CHEMISTRY OF CLEANING. Krieger, G. L. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1966. Contract AT(29-1)-789. 118p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effects of contaminants on the properties of materials important to electronic devices and to related vacuum processes are discussed. Modern methods of achieving, testing for, and maintaining cleanliness are described. (P.C.H.)

5847 (UCRL-17185) IONIC RECOMBINATION IN WEAKLY IONIZED GASES. Fisk, George A. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1966. Contract W-7405-eng-48. 66p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

A study was made of ionic recombination rates in the lead iodide, lead bromide, and thallium iodide systems. The pressure dependence of the ion–ion recombination coefficient α was studied in the lead iodide system at 594°K and in the lead bromide system at 707°K. In both cases xenon at pressures up to 150 torr and argon at pressures up to 400 torr were used as third body gases. In all cases the recombination coefficient could be expressed as $\alpha = \alpha_0 + \alpha' \times N$ where N is the number density of the third body gas (atoms/cm^3). For lead iodide $\alpha_0 = 3.7 \times 10^{-8}$(cm^3/sec), $\alpha' = 9.3 \times 10^{-27}$(cm^6/sec) in argon, and $\alpha' = 19.1 \times 10^{-27}$ in xenon. For lead bromide $\alpha_0 = 5.3 \times 10^{-8}$, $\alpha' = 15.3 \times 10^{-27}$ in argon, and $\alpha' = 20.6 \times 10^{-27}$ in xenon. Currently available theories do not predict these values. The temperature dependence of α was studied in the thallium iodide system over the range from 484 to 728°K. No simple theoretical or empirical expression describes the dependence of α on T over this range, although α decreases with increasing temperature over most of the range, as predicted by theory. (auth)

5848 (UCRL-50108(Vol.1)) COMPENDIUM OF SHOCK WAVE DATA. Sections A-1, A-2. van Thiel, M. (ed.) (California Univ., Livermore. Lawrence Radiation Lab.). June 1966. Contract W-7405-eng-48. 608p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Tables and graphs are presented which give the thermodynamic data in condensed media obtained by shock wave techniques. Both dynamic variables and volumetric quantities associated with the shock wave are given. The media covered include elements and compounds. (D.L.C.)

5849 (USNRDL-TRC-85) THE ELECTROCHROMATOGRAPHY OF SEAWATER CONTAINING DISSOLVED PLUTONIUM. Lingren, W. E. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 26, 1966. Contract AT(49-7)-1963. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Electrochromatographic techniques were used to determine the chemical form of plutonium in sea water. If either Pu(III), Pu(IV), or PuO_2^{2+} was added to a 0.7 M NaCl–0.0023 M Na_2CO_3 solution, it was found that in each case about 30% of the plutonium would migrate to the anode and 70% would not migrate. Similar results were obtained in solutions containing other anions found in sea water. Plutonium electromigration experiments using NaCl solutions containing varying concentrations of Na_2CO_3 indicated the presence of an anionic complex that is sensitive to carbonate ion concentration. This behavior was not found with other anions in sea water. Plutonium from plutonium metal dissolved in sea water was found to migrate in the same way as Pu(III), Pu(IV), and PuO_2^{2+}. This indicates that the same final chemical form is reached for both the dissolved metal and the added plutonium ions. Plutonium from high fired PuO_2 beads dissolved in seawater was found to migrate about 23% to the cathode and 22% to the anode; 55% did not migrate at all. This does not correspond to the migration behavior of the dissolved metal or the added plutonium ions; however, there is inconclusive evidence that the anionic fraction is the same carbonato–complex of plutonium. (auth)

5850 (ORNL-tr-1414) ON A COLLOIDAL COMPOUND OF THORIUM WITH URANIUM. Szilard, Bela. Translated by R. G. Mansfield (Oak Ridge National Lab., Tenn.), from Compt. Rend., 143: 1145-7(1906). 4p. Dep. mn. JCL $1.10 fs, $0.80 mf.

To prepare a colloidal mixture of thorium and uranium, thorium hydroxide is precipitated by the addition of ammonia, the precipitate is mixed with a solution of uranium nitrate, and the temperature of the mixture is raised. Other methods of preparation showed that the compound formed is very well defined and is truly of a colloidal nature. The salt, when it no longer lost water drying in vacuo, was analyzed and found to contain 72 to 74% Th, 4 to 5.5% U, 12 to 13% H_2O, and 10 to 11% O. (M.C.G.)

5851 (ORNL-tr-1415) ON THE COLLOIDAL HYDROXIDES OF THORIUM, ZIRCONIUM, AND URANYL. Szilard, B. Translated by R. G. Mansfield (Oak Ridge National Lab., Tenn.), from J. Chim. Phys., 5: 488-94(1907). 9p. Dep. mn. JCL $1.10 fs, $0.80 mf.

The preparation and properties of colloidal hydroxides of thorium, zirconium, and uranyl in the presence of and without electrolytes are described. (P.C.H.)

5852 THERMOLUMINESCENCE FROM RECOMBINATION OF ORGANIC IONS. Brocklehurst, B.; Russell, R. D. (Univ. of Sheffield, Eng.). Nature, 213: 65(Jan. 7, 1967).

Previous investigations on ion recombination in solutions of naphthalene in a hydrocarbon glass (2 parts methylcyclohexane: 3 parts isopentane) giving rise to luminescence on warming (thermoluminescence) or on infrared stimulation were extended. A more careful estimate of the thermoluminescence yield gave a G-value of the order of 0.1 (previous estimate 10^{-6}). The G-value for trapped ions is about 1. Since the luminescence yield of excited naphthalene is low, the majority of the recombining ions probably produce excited states. Further study of the emission spectrum showed that in addition to naphthalene fluorescence and phosphorescence, emission from the excimer $(C_{10}H_8)_2^-$ also occurs. In addition to $C_{10}H_8^-$ and the $C_{10}H_9$ radical, $C_{10}H_8^+$ was detected in the visible absorption spectrum after irradiation. It is supposed that luminescence results from recombination of $C_{10}H_8^+$ and $C_{10}H_8^-$, which diffuse together on warming the solvent. Because emission is observed both from excimers and single molecules it is possible that the negative ion dissociates into $C_{10}H_8$ and an electron during the diffusion process. Addition of large amounts of CO_2 removes the $C_{10}H_8^-$ absorption, leaving the $C_{10}H_8^+$. The thermoluminescence is somewhat weakened and consists only of phosphorescence. This suggests that recombination of $C_{10}H_8^+$ with CO_2^- can lead to excitation, but there is insufficient energy available to produce the excited singlet state. (UK)

5853 THERMOGRAVIMETRIC ANALYSIS OF THORIUM SULFATE COMPLEX COMPOUNDS. Molodkin, A. K.; Skotnikova, G. A.; Ivanova, O. M. Zh. Neorg. Khim., 11: 2241-54(Oct. 1966). (In Russian).

A thermogravimetric analysis was made of the following sulfate compounds of thorium: $Th(SO_4)_2 \cdot nH_2O$ (n = 9, 7.5, 7.25, 3.5), $Me_2Th(SO_4)_3 \cdot nH_2O$ (Me = NH_4^+, n = 5; Na^+, n = 6; K^+, n = 4; Rb^+, n = 0; Cs^+, n = 2; $\frac{1}{2}CN_2H_6Na^+$, n = 6), $Me_4Th(SO_4)_4 \cdot nH_2O$ (Me = NH_4^+, n = 2; K^+, n = 2; Rb^+, n = 0; Cs^+, n = 1); $Me_6Th(SO_4)_5 \cdot 3H_2O$ (Me = NH_4^+, Cs^+); and $(NH_4)_8Th(SO_4)_6 \cdot 2H_2O$. It was found that the thorium disulfate and the ammonium compounds during heating from 750 to 900°C are decomposed to thorium dioxide without melting and formation of thermally stable intermediate products (in addition to $Th(SO_4)_2$). All the sulfate compounds of thorium with alkali elements are decomposed initially on heating into cations. Anhydrous complexes are stable over a wide temperature interval. The structure of the sulfate complex compounds of thorium, their coordination formulas, and their nomenclature are considered. (tr-auth)

5854 COMPLEX EMANATION-THERMAL STUDIES OF CALCIUM, ALUMINUM, AND THORIUM. Zaborenko, K. B.; Tetner, R. Zh. Neorg. Khim., 11: 2197-2201(Oct. 1966). (In Russian).

Complex emanation-thermal methods were used to study the hydroxides of calcium, aluminum, and thorium. Comparison of emanation measurements with the results of other physicochemical methods made it possible to describe more completely the dehydration processes of the hydroxides and the conversion processes of the oxides being formed. From measurements on the hydroxides, it was found that in contrast to other thermal methods, the emanation method demonstrates the distinct character of the transition of hydroxides to oxides. A more accurate picture of the thermal decomposition of thorium hydroxide was obtained. The emanation isotherms revealed a bond between separation of thorium and the

condition of the structure at each moment of the conversion of the hydroxide–oxide system. During investigation by the plan polytherm → isotherm → polytherm it was found that the polytherm of the emanation of the original substance reflects all transition structural states of the solid. (tr-auth)

5855 DEUTERIUM ISOTOPE EFFECT AND THE MOLECULAR DYNAMICS OF WATER IN BENZENE. Moule, D. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 44: 3009-15(Dec. 15, 1966).

Infrared spectra of H_2O and D_2O in benzene were recorded and the solubilities of light and heavy water in benzene from 10 to 50°C measured. Isotope fractionation factors for the distribution of HDO and H_2O between the vapor and liquid benzene phases were calculated from the relative solubilities and the vapor pressure ratios of pure H_2O and D_2O. The isotope equilibrium data were fitted to the expression $\ln \alpha = -A/T^2 + B/T$ and interpreted by the Bigeleisen formulism. The intramolecular B term was determined from the solvent shifts of the near infrared frequencies and the intermolecular A term calculated by a least squares fit to the isotope equilibrium data. Spectral and equilibrium data were combined to give 220 $cm^{-1} \simeq \nu_{Ry} > \nu_{Rx} > \nu_{Rz} \geq 120$ cm^{-1}. (auth)

5856 EFFECT OF URANIUM ON CATALYSTS CONTAINING METALS OF GROUP VIII OF THE PERIODIC SYSTEM. Nicklin, T. (North Western Gas Board, Manchester, Eng.); Whittaker, R. J.; Dixon, M. Nature, 212: 1357-8(Dec. 17, 1966).

A marked improvement in the parameters of the reaction between steam and hydrocarbons was obtained when U was introduced into the catalyst formulation. The catalysts were prepared by impregnation of an inert support with the metal salts, the support being in the form of pure α-aluminum oxide. A preliminary physicochemical examination of catalysts containing U indicated that U was probably acting as an electronic promoter. The addition of U to the nickel–α-aluminum oxide catalyst caused the total surface area to be increased from that of the base support. Since U (as U_3O_8) on α-aluminum oxide gives rise to a very small surface area value, the U either reduced the crystallite size of the nickel atoms or combined with the nickel to form a compound of high total surface area. An x-ray examination of these catalysts showed the existence of a new phase, probably as a result of the combination of Ni and U. When a catalyst was prepared which contains this complex, a much stronger adsorption of hydrogen was observed when compared with catalysts containing nickel alone. The presence of U in these catalysts had important effects on the kinetics of the reactions involved in the steam–hydrocarbon reforming reactions. (D.H.M.)

5857 MICROWAVE SPECTRUM, DIPOLE MOMENT, STRUCTURE, AND INTERNAL ROTATION OF DIMETHYL SELENIDE. Beecher, James F. (Univ. of Notre Dame, Ind.). J. Mol. Spectros., 21: 414-24(Dec. 1966).

The microwave spectra of five isotopic species of dimethyl selenide are reported. Structural parameters for changes in rotational constants with isotopic substitution are given. From Stark effect measurements the dipole moment of dimethyl selenide was found to be 1.41 ± 0.02 Debye. The fine structure in the ground-state rotational spectrum of all five isotopic species was resolved and analyzed. This fine structure results from coupling of internal and overall rotation. The height of the potential barrier hindering internal rotation was determined as 1500 ± 20 cal/mole. (auth)

5858 A SIMPLIFIED VALENCE FORCE FIELD OF AROMATIC HYDROCARBONS. I. NORMAL CO-ORDINATE CALCULATIONS FOR C_6H_6, C_6D_6, $C_{10}H_8$, $C_{10}D_8$, $C_{14}H_{10}$, AND $C_{14}D_{10}$. Neto, N.; Scrocco, M.; Califano, S. (Univ., Florence. Univ., Naples). Spectrochim. Acta, 22: 1981-98(Dec. 1966).

A simplified valence force field is reported for aromatic hydrocarbons and their deuterated species. Experimental work was conducted using benzene force constants, extended to anthracene and naphthalene. Results indicated a force field for benzene including only ten independent force constants with 23 for naphthalene and 27 for anthracene. Tabulated comparisons with observed and calculated data are in agreement with previous Urey–Bradley calculations for benzene and naphthalene but there is serious disagreement with anthracene. (P.C.S.)

5859 RECENT DEVELOPMENTS IN THE KINETICS OF EXCHANGE REACTIONS. Anantakrishnan, S. V. (Madras Christian Coll.). J. Sci. Ind. Res. (India), 25: 395-400(Sept. 1966).

Recent work on the kinetics of exchange reactions, with special reference to reactions involving hydrogen, carbon, oxygen, bromine, nitrogen, and complex metal ions, was critically reviewed. Isotopic exchange in substitution reactions and rearrangements in synthetic organic chemistry, radioinduced (X, γ, and β rays) exchange, exchange reactions in organic syntheses and enzyme reactions are some of the topics discussed. (auth)

5860 INFRARED SPECTRA OF SULFAMIDE AND SULFAMIDE-d_4. Uno, T.; Machida, K.; Hanai, K. (Kyoto Univ.). Spectrochim. Acta, 22: 2065-73(Dec. 1966).

Infrared spectra of sulfamide-d_4 were recorded for ordinary and polarized radiations. The vibrational assignment was made by referring to the infrared dichroism as well as to the isotopic effect. Normal coordinate analysis of sulfamide and sulfamide-d_4 as nine atomic molecules was carried out by assuming the molecular symmetry of C_{2v}. Calculation of potential energy distributions showed that the shift of the N–S–N symmetric and antisymmetric stretching bands on N-deuteration is attributed to the vibrational coupling between the S–N stretching and the ND_2 bending vibrations. (auth)

5861 REFLECTION OF SOFT X-RAYS BY ORGANIC FIBERS. Newman, Sanford B. (National Bureau of Standards, Washington, D. C.). J. Appl. Polymer Sci., 10: 1929-35(Dec. 1966).

An artifact observed in point projection microradiographs of polymeric fiber and filaments obtained with 8-A x rays is recorded and described. The phenomenon was related to fiber-beam geometry and the high-reflection efficiency of soft x rays for these materials. (auth)

5862 THE MINIMUM-RESIDUAL REFINEMENT OF β-URANIUM FROM POLYCRYSTALLINE DATA. Steeple, H.; Ashworth, T. (Univ. of Manchester, Eng.). Acta Crystallogr., 21: 995-8(Dec. 10, 1966).

The non-centrosymmetric and centrosymmetric structures of β-uranium were refined from x-ray powder intensities by the minimum-residual method programmed for the Atlas computer. The agreement residuals of 0.19 for the former and 0.32 for the latter structure have been improved respectively to 0.16 and 0.23, and for the noncentrosymmetric structure this improvement has been accompanied by a further shortening to 2.50 Å of the already short distance of 2.53 Å between atoms in neighboring main layers. (auth)

5863 THE URANIUM–IRON–SILICON SYSTEM. THE NEW PHASE U_2FeSi_3. de Lourdes Pinto, Maria (Laboratorio de Fisica e Engenharia Nucleaires, Sacavem, Portugal). Acta Crystallogr., 21: 999(Dec. 10, 1966).

During an investigation of the ternary system U–Fe–Si, a new phase with the approximate composition U_2FeSi_3 was found. The new phase appears to have a large range of homogeneity and lies on the quasi-binary section UFe_2–USi_2. Structure determination exclusively based on the powder data showed this particular phase to belong to the hexagonal system (space group P6/mmm). Unit-cell dimensions for the composition $U(Fe_{0.20}, Si_{0.80})_2$ were found to be a = 4.01, c = 3.84 (c/a < 1). Density measurements showed that the unit cell contains $1/2(U_2FeSi_3)$. From these data it was assumed that the atoms occupy the following positions: 1 U in (a), 2 (Fe, Si) in (d) (C_{32}-type structure). (P.C.H.)

5864 ON THE ACTION OF THORIUM AND ZIRCONIUM IONS ON ALDOSES. Trapmann, H.; Sethi, V. S. (Univ., Munich). Arch. Pharm., 299: 657-62(Aug. 1966). (In German).

In solutions of monosaccharides, the salts of Th and Zr cause a yellow to brown coloration, which is related to the formation of 5-hydroxymethylfurfural for aldohexoses and furfural from aldopentoses. The catalytic effect of the metals is significantly greater than the effect of HCl. Illustrations of the reactions of galactose and arabinose with Th and Zr salts at 70°C are given. In concentrated solutions the effect of Th is greater than that of Zr, but Zr is more effective than Th in dilute solutions. The formation of the product was followed spectrophotometrically for 2 ml of 20% aldose and 0.1 ml of 0.1M metal and determined after 30-min heating at 120-125°C. Studies were made of glucose, galactose, mannose, arabinose, xylose, sorbose, and fructose. For keto sugars the reaction is not accelerated so greatly by Th and Zr, although it is still more rapid than the HCl-catalyzed reaction. (BBB)

5865 CATHODIC POLARIZATION OF METALS AND ALLOYS AND ITS APPLICATIONS IN THE NUCLEAR INDUSTRY. Raviv, S.; Rabinovitz, E.; Malkiely, S. (Centre de Recherches Nucleaires, Neguev, Israel). J. Nucl. Mater., 20: 287-93(Sept. 1966). (In French).

A knowledge of the mechanism of cathodic polarization of metals in various acids is of practical interest for the nuclear industry. After a brief survey of research in this field, the possible ways of applying cathodic polarization are reviewed. The most important applications include the selective dissolution of cans from nuclear fuels, cathodic decontamination of steels, and the dissolution and separation of metals and alloys. (auth)

5866 ZIRCONIUM–MOLYBDENUM NITRIDES. Brauer, G.; Leibbrandt, F. (Univ., Freiburg i. B.). J. Less-Common Metals, 12: 57-62(1967).

Zirconium–molybdenum alloys with 10, 30, 50, 70, and 90 at. % molybdenum and the hydrides of some of these alloys were reacted with ammonia at 740°C to give the nitrides. The alloys from pure zirconium through $Zr_{0.5}Mo_{0.5}$ formed a nitride phase having a face-centered-cubic structure of the δ-ZrN type The alloy $Zr_{0.1}Mo_{0.9}$ formed a fcc nitride phase of the γ-$(Mo,Zr)_2N$ type. In the region of the metal ratio $Zr_{0.3}Mo_{0.7}$, a miscibility gap occurred, and the two different nitride phases appeared simultaneously. (auth)

5867 STABILITY CONSTANTS OF URANYL CHELATES WITH NUCLEAR-SUBSTITUTED SALICYLIC ACIDS. Mohan Rao, J.; Seshaiah, U. V. (Osmania Univ., Hyderabad, India). Bull. Chem. Soc. Jap., 39: 2668-71(Dec. 1966).

The formation of an orange-red colored water soluble chelate between uranyl ion and p-aminosalicylic acid with maximum absorption at 460 mμ is reported. The color of the complex is fairly stable and attains maximum intensity at pH 4.5. The composition of the complex has been evaluated by Job's and mole ratio methods employing absorbance data and has been found to be 1:1 with respect to metal and ligand. The stability constants of the uranyl chelates of certain nuclear substituted salicylic acids, such as, 3-nitrosalicylic, 5-sulfosalicylic, β-resorcylic, and p-aminosalicylic acids have been determined and the validity of the linear relationship between ligand basicity and the metal chelate stability studied. Based on pH and adsorption studies, tentative structures for the above uranyl chelates have also been proposed. (auth)

5868 STUDIES OF SCANDIUM IN VARIOUS SOLUTIONS. III. THE SOLVENT EXTRACTION AND COMPLEX FORMATION OF SCANDIUM(III) WITH ACETYLACETONE AND THENOYLTRIFLUOROACETONE. Sekine, Tatsuya; Koizumi, Akira; Sakairi, Mitsuo (Tokyo Coll. of Science). Bull. Chem. Soc. Jap., 39: 2681-4(Dec. 1966).

The distribution of scandium(III) at a tracer concentration was determined between chloroform with acetylacetone or thenoyltrifluoroacetone and 0.1M aqueous perchlorate solutions at 25°C. The change in the distribution ratio of the metal ion with the change in the chelating acid concentration or with the change in the hydrogen ion concentration was explained in terms of the extraction of the tris chelate complexes into the organic phase and the formation of the primary complexes in the aqueous phases. The equilibrium constants in these systems were determined graphically, by a curve-fitting method. (auth)

5869 THE MECHANISM OF THE CATALYTIC HYDROGENATION OF PROPENE ON NICKEL, PALLADIUM, AND PLATINUM. (THE APPLICATION OF MICROWAVE SPECTROSCOPY TO ISOTOPIC ANALYSIS). Hirota, Kozo; Hironaka, Yoshie (Osaka Univ.). Bull. Chem. Soc. Jap., 39: 2638-42 (Dec. 1966).

The catalytic hydrogenation of propene with deuterium gas and its isotopic exchange reaction with deuterium oxide have been carried out at room temperature, and the remaining propene has been subjected to microwave spectroscopic analysis so as to determine the isotopic isomer-distribution of propene-d_1 and -d_2. From the results, it was found that the rate-determining step in the hydrogenation on platinum as well as nickel and palladium catalysts is the addition of hydrogen to the half-hydrogenated species. The kinds of chemisorbed species and their distribution prior to the rate-determining step are not always the same, but depend on the metals. The lifetime of the chemisorbed propene is shorter than the successive time interval of its exchange process on nickel, but this is not the case on platinum nor, probably, on palladium. (auth)

5870 URANATES OF SOME METALS AND THE OXIDATION OF URANIUM DIOXIDE. I. CALCIUM URANATE. Jakes, D.; Moravec, J.; Krivy, I.; Sedlakova, L. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Z. Anorg. Allg. Chem., 347: 218-22(Nov. 1966). (In German).

The compounds $CaUO_4$, CaU_2O_7, Ca_3UO_6, and Ca_2UO_5 were prepared and characterized by means of x-ray and ir-techniques. Annealing UO_2 doped with 5 wt % CaO in air yielded no ir-detectable amounts of uranate(VI). (auth)

5871 INFRARED SPECTRA OF SODIUM URANATES. Baran, V.; Tympl, M. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Z. Anorg. Allg. Chem., 347: 175-83 (Nov. 1966).

The uranyl hydrolytic precipitates with successively changed Na/U ratios were measured in the region 400 to 3600 cm^{-1}. The results indicate the uranyl to be influenced by sodium content; its antisymmetric frequency shifts linearly against Na/U. Two forms of hydroxyl groups are present—the first is influenced by sodium substitution, the second is not. Sodium uranates contain no water of crystallization but certain amounts of non-stoichiometric water molecules, which can be removed rather difficultly even at elevated temperatures, are present. (auth)

5872 THERMAL ANALYSIS OF SODIUM URANATES. Baran, V.; Tympl, M. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Z. Anorg. Allg. Chem., 347: 184-90 (Nov. 1966).

Thermal analysis of the uranyl hydrolytic precipitate with systematically changed Na/U ratios gives two main effects. The first (ca 50 to 200°C) is caused by removing nonstoichiometric water molecules; its magnitude is inversely proportional to the sodium content (i.e., a mutual substitution of H_2O for Na). The second one (ca 200 to 450°C) is composed and belongs to dehydration of hydroxyl groups (first, the bridging, then nonbridging ones). The water molecules formed leave the solid difficultly. (auth)

5873 DIFFUSION OF IONS OF URANIUM AND MOLYBDENUM IN MOLTEN CHLORIDES OF ALKALI METALS. Smirnov, M. V.; Shabanov, O. M. (Inst. of Electrochemistry, Academy of Sciences, Sverdlovsk SSR). Elektrokhimiya, 2: 953-7(1966). (In Russian).

An examination was made of the mechanism of diffusion of multicharged cations in molten chlorides of Cs, K and Li where they form complex anionic groupings. Displacement of the cation exchange resins occurs chiefly in the composition of complexes, the size and charge of which determine the relaxation retardation on the part of the atmosphere of cations of the salt–solvent. The diffusion coefficients of the above ions calculated on the basis of this mechanism agree with experimental data. Discussions of why the ion of trivalent uranium diffuses more rapidly than the tetravalent whose radius is smaller, and the diffusion rate of trivalent molybdenum decreases with increase in radius of the salt–solvent in the transition from lithium chloride to cesium chloride in spite of decrease in viscosity of the medium in this case are presented. (JPRS)

5874 BINARY SYSTEM URANIUM TETRAFLUORIDE–URANIUM DIOXIDE. Khripin, L. A.; Luk'yanova, L. A. (Inst. of Inorganic Chemistry, Nosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser. Khim. Nauk, No. 1, 131-3(1966). (In Russian).

In a study of the UF_4–UO_2 system the UF_4 used was separated from its UO_2F_2 and UO_2 impurities by vacuum distillation under residual pressure of the order of 10^{-4} mm Hg at 1000°C. Tests were made with the wt % UO_2 varying from 0 to 72.5% The system was studied by differential thermal analysis. A phase diagram was constructed based on the data. The results indicated that the melting point of UF_4 changed comparatively little when the content of uranium dioxide did not exceed about 10%. With the presence in the mixture of up to 20% UO_2, the melting point was lowered by almost 60°C, which does not confirm earlier literature data. It was established that this system (up to 75% UO_2) belongs to the simple eutectic type. The eutectic corresponds to a temperature of 920°C and a composition with 24.5 wt % UO_2. The results are compared with existing literature data. (ATD)

5875 INORGANIC ION EXCHANGERS. IV. THE SORPTION ON CRYSTALLINE ZIRCONIUM PHOSPHATE AND ITS DEPENDENCE UPON THE CRYSTALLINITY. Albertsson, Joergen (Univ. of Lund, Sweden). Acta Chem. Scand., 20: 1689-1702 (1966).

Crystalline zirconium phosphate, of composition $Zr(HPO_4)_2 \cdot H_2O$, was prepared. The x-ray powder photographs could be indexed on the basis of a hexagonal unit cell of dimensions a = 10.5 Å and c = 45.6 Å. The neutralization curve, obtained in a Na^+ medium, indicated that the monohydrogen phosphate groups existed in two states of acidity. When a Cs^+ medium was used, only the more acid portion of the groups could be loaded. The hydrolysis of crystalline zirconium phosphate depended on the size of the cation present and was extensive when Cs^+ was sorbed. The sorption of Cs^+ on preparations of various crystallinity was investigated and a simplified picture of the sorption was developed, more especially for the gels. Besides the ordinary monohydrogen phosphate groups, all the preparations appeared to contain small amounts of another functional group with a high affinity to certain cations, especially Cs^+. The sorption on crystalline zirconium phosphate of Na^+, Cs^+, UO_2^{2+}, and Ce^{3+} was probably a perfect cation exchange. The behavior of Sr^{2+} was irregular and it appeared to be irreversibly sorbed. The following affinity series was found: $Sr^{2+} \geq UO_2^{2+} \geq Ce^{3+} > Na^+ > Cs^+$. (auth)

5876 PRIMARY HYDROGEN ISOTOPE EFFECTS IN THE NUCLEAR BROMINATION OF 1,3,5-TRIMETHOXY-2-METHYLBENZENE AND 1,3,5-TRIMETHOXY-2,4-DIMETHYLBENZENE. Helgstrand, Erik; Nilsson, Ake (Univ. of Goeteborg, Sweden). Acta Chem. Scand., 20: 1463-9(1966).

The substrates, prepared by direct methods from 1,3,5-trimethoxybenzene, were brominated by molecular bromine in di-

methylformamide. A competitive method using partially deuterated compounds gave the isotope effects $k_D/k_H = 0.49 \pm 0.04$ and $k_D/k_H = 0.34 \pm 0.04$ for the bromination of 1,3,5-trimethoxy-2-methylbenzene and 1,3,5-trimethoxy-2,4-dimethylbenzene, respectively, at −20°C. For the former substance, the influence on the isotope effect of added water, sodium perchlorate, and sodium bromide was studied. It was found that the apparent isotope effect became stronger with increasing concentration of bromide ion. (auth)

5877 BOND ORDERS IN URANYL COMPOUNDS. Vdovenko, V. M.; Mashirov, L. G.; Suglobov, D. N. Dokl. Akad. Nauk SSSR, 167: 1299-1302(Apr. 21, 1966). (In Russian).

In the UO_2 lattice a uranium atom is surrounded by eight equivalent atoms of oxygen and in δ-UO_3, by six. From a tabulation of interatomic distances, orders, and force constants of U−O bonds in a number of uranyl compounds, it was concluded that the sum of the orders of the bonds is close to 6. The orders of the uranyl and equatorial bonds in U(VI) are interdependent, and only in the absence of equatorial bonds can the uranyl bond attain the order 3. The interatomic distance in a "free" uranyl ion with a ternary bond, $U \equiv O$, is 1.59 A. A graph of the force constant versus bond order is a straight line. The U−O bond orders in uranium and uranyl ligands for several complexes—perchlorates, tributylphosphates, and others—are tabulated. Since the charge on a uranium atom is zero, in a free uranyl ion with a bond order of 3 the charge on each oxygen atom is +1. As the order decreases, the positive charge "overflows" from the uranyl group atoms to the ligands. (TTT)

5878 DETECTION OF KINETIC DEUTERIUM ISOTOPE EFFECTS IN NUCLEOPHILIC SUBSTITUTIONS IN BISCHLORONITROSO COMPOUNDS. Collin, Gerd; Pritzkow, Wilhelm; Huebner, Heinrich; Rolle, Wolfgang; Wahren, Manfred (Technische Hochschule Merseburg, Ger.). Tetrahedron Lett., No. 29, 3493-8(July 1966). (In German).

The isotope effect for the reaction of bischloronitroso compounds with alkoxides and amines to yield aminoöximes and alkoxyoximes was examined. The rate law is of second-order dependence for the formation of the aminoöxime, being proportional to the concentrations of amine and bischloronitroso compound. Activation parameters for the reaction of the bischloronitroso compounds from methylenecyclopentane and methylenecyclohexane with diethylamine, diisobutylamine, piperidine, and methoxide (CH_3O^-) are tabulated. The isotope effects for the compounds from the methylene-deuterated alkenes were found to be: methylenecyclopentane with diethylamine, $k_H:k_D = 4.6$, with piperidine, 4.1; methylenecyclohexane with diethylamine, 5.8, with piperidine, 4.9. The elimination step of the reaction is taken to be E_2. (BBB)

5879 A STERIC ISOTOPE EFFECT AS THE CAUSE OF A CATALYTIC ASYMMETRIC SYNTHESIS. Pracejus, H. (Institut fuer Organische Katalyseforschung, Deutsche Akademie der Wissenschaften zu Berlin, Rostock, Ger.). Tetrahedron Lett., No. 32, 3809-13(Aug. 1966). (In German).

The synthesis of α-phenylpropionic acid methyl ester from phenylmethylketene and methanol produces an optically active compound if an optically active quinuclidine derivative, 2,2-dimethyl-1-aza-(2.2.2)-bicycloöctane-6,6-d_2, is used as catalyst. This compound is prepared from (+)-2,2-dimethyl-piperidyl-4-acetic acid ethyl ester hydrochloride by liberation of the free base with K_2CO_3 solution, reduction with two moles $LiAlD_4$ in ether, reaction with 67% HI (16 hr, 100°C), and cyclization with 0.1N NaOH in overall yield of 73%. The configuration is probably 1S:4R from the Brewster rules. When it is used as catalyst for the ketene reaction, the mean optical yield is 0.13%. No temperature dependence of the effect was noted between −95 to 62°C. Thermodynamic quantities were evaluated. (BBB).

5880 CHROMATOGRAPHY OF ANIONIC BROMIDE AND IODIDE COMPLEXES OF METALS ON PAPER IMPREGNATED WITH TRI-n-OCTYLAMINE. Przeszlakowski, Stanislaw; Soczewinski, Edward (Katedra Chemii Nieorganicznej, Wydzial Farmaceutyczny Akademii Medycznej, Lublin). Chem. Anal. (Warsaw), 11: 895-903(1966). (In Polish).

Chromatographic behavior of Be(II), Sc(III), La(III), Ti(IV), Zr(IV), Cr(III), W(VI), Mn(II), Fe(III), Co(II), Ni(II), Pd(II), Pt(IV), Cu(II), Ag(I), Au(III), Zn, Cd, Hg(II), Al, Ga(III), In(III), Tl(I), Ge(IV), Sn(II), Pb(II), As(III), Sb(III), Bi(III), Se(IV), Te(IV), Th(IV), and U(VI) on paper impregnated with tri-n-octylamine hydrobromide or tri-n-octylamine hydroiodide, using aqueous solutions of HbR, NaBr, or NaI as mobile phase was studied. Effects of amine concentration in the impregnating solution on the R_F and R_M coefficients of U(VI), Cu(II), and Pb were also investigated. Different behavior of various metals depending on the halogenide ion concentration in the mobile phase made possible the selection of optimal conditions for chromatographic separation of certain metals e.g.: Bi, Cu, Co; Sn, Pb, As, Ge; Hg, Pb, Ag, Sb, etc. Patterns of relationships between HBr concentration in mobile phase and R_F coefficients for Pb, Cu(II), Fe(III), and U(VI) closely resembled those observed in experiments carried out on Amberlite IRA 400 anion-exchanger coated paper (G. Bagliano, G. Grassini et al., J. Chromatogr., 14: 238(1964)). This fact confirms the ion exchange mechanism of the chromatographic process carried out on paper impregnated with tri-n-octylamine. The partition character of this process allows the approximate evaluation of conditions necessary for isolation or separation of metals by amine extractions from bromide or iodide solutions. (auth)

5881 THE MECHANISM OF OXIDATION OF α-GLYCOLS BY PERIODIC ACID. PART VI. OXIDATION OF PINACOL AT pH 0-6. Buist, G. J.; Bunton, C. A.; Lomas, J. (London Univ. Battersea Coll. of Tech., London. Univ. of California, Santa Barbara). J. Chem. Soc. (B), No. 11, 1094-9(1966).

The oxidation of pinacol by periodic acid had a second order kinetic form in the region pH 0 to 6, with a rate maximum at pH 1. The variation of rate with pH was consistent with a mechanism involving the formation of a pinacol-periodate monoester which cyclizes to a diester which decomposes to the reaction products. At pH > 2 the reactants and monoester are in equilibrium, but at pH < 2 the formation of the monoester becomes slow. A large kinetic salt effect observed in the range pH 2 to 4 was probably caused by the salt effect on the dissociation of periodic acid. The reaction rate in the region of the maximum was about 30% slower in D_2O than in H_2O. There was no appreciable deuterium isotope effect on the apparent first dissociation of periodic acid. (auth)

5882 HYDROGEN ISOTOPE EXCHANGE REACTIONS OF NON-BENZENOID AROMATICS. III. AROMATICITY IN PSEUDOAZULENES. V. REACTIVITY MEASUREMENTS ON 2,3;5,6-DIBENZOXALENE AND ON N-METHYL-2,3;5,6-DIBENZAZULENE. Weiss, C.; Schoenfeld, D. (Karl-Marx-Univ., Leipzig). Tetrahedron, 22: 2511-14(Aug. 1966). (In German).

The compounds studied were deuterated by acids in the 1 position. The hydrogen exchange rates of these pseudoazulenes and of 3 azulenes in a mixture of equal volumes of 0.05N CH_3COOD in CH_3OD and benzene at 100°C were determined and found to fit the LCAO-MO reactivity indexes calculated by Borsdorf. The rates are first-order, with constants as follows: 2,3; 5,6-dibenzoxalene, $3.4 \pm 0.2 \times 10^{-5}$ sec^{-1}; N-methyl-2,3; 5,6- dibenzazulene, $2.6 \pm 0.7 \times 10^{-4}$ sec^{-1}; azulene, $2.0 \pm 0.1 \times 10^{-5}$ sec^{-1}; 2,3-benzazulene, $7.9 \pm 1.0 \times 10^{-5}$ sec^{-1} at a different acid concentration. Data for the same concentration of acid for benzazulene are given as $7.5 \pm 1.0 \times 10^{-6}$ sec^{-1}. Graphical data illustrate the dependence of the rate of exchange on the pi density in the 1 position for these compounds and for 1-phenylazulene. (BBB)

5883 URANIUM CARBIDE, REFRACTORY METAL INTERACTIONS AT HIGH TEMPERATURE. Allinson, J. D. (Atomic Energy Research Establishment, Harwell, Eng.). Rev. Int. Hautes Temp. Refract., 3: 255-9(July-Sept. 1966).

Sintered pellets of UC were wrapped with foils of refractory metals and heated in a high-temperature vacuum furnace at a pressure of 2×10^{-6} torr. It was found that liquid-phase reactions occurred at temperatures many hundreds of degrees below the respective melting points of either the uranium carbide or the refractory metals. Isotherms of the U−Nb−C and U−Mo−C systems are given. The U−W−C system was also studied. (M.C.G.)

5884 SORPTION OF DEUTERIUM AT VERY LOW PRESSURES BY MOLYBDENUM FILMS. Pasternak, R. A.; Endow, N. (Stanford Research Inst., Menlo Park, Calif.). J. Phys. Chem., 70: 4044-50(Dec. 15, 1966).

The thermodynamics and kinetics of deuterium adsorption by porous molybdenum films were studied at very low pressure over a temperature range from 77 to 373°K. The isobars and isotherms, and isosteric heats derived from them, indicate the existence of at least two adsorption states, one of which is stable only at temperatures below 200°K. The rate curves show a corresponding change in character. At all temperatures the sticking probability on the exposed surfaces is high, about 0.5; however, at low temperatures the internal surfaces are reached by flow through the pores and at high temperatures by fast surface diffusion. Consideration of the interrelation between binding energy and activation energy of diffusion strongly suggests that deuterium is adsorbed atomically even in the low-temperature state. (auth)

5885 IONIZATION CONSTANT OF DEUTERIUM OXIDE FROM 5 TO 50 DEG. Covington, A. K.; Robinson, R. A.; Bates, Roger G. (National Bureau of Standards, Washington, D. C.). J. Phys. Chem., 70: 3820-4(Dec. 15, 1966).

Electromotive force measurements of a cell without liquid junction were used to determine the ionization constant of deuterium oxide from 5 to 50°C. The value found for pK at 25°C is 14.955

(molality scale), 14.869 (molarity scale), and 16.653 (mole fraction scale). Enthalpy, entropy, and heat capacity changes for the dissociation process were evaluated. (auth)

5886 DETECTION OF METAL ION HYDROLYSIS BY COAGULATION. VII. NEPTUNIUM(IV). Wear, J. O.; Matijevic, E. (Southern Research Support Center, Little Rock, Ark. Clarkson Coll. of Tech., Potsdam, N. Y.). J. Phys. Chem., 70: 3825-9 (Dec. 15, 1966).

The coagulation and reversal of charge of silver chloride, silver bromide, and silver iodide sols in statu nascendi by neptunium(IV) perchlorate were investigated as a function of pH. The entire log $[Np(ClO_4)_4]$-pH domain for all three sols is given delineating the regions of uncoagulated sol, coagulated sols, and sols reestablished due to charge reversal. The results are discussed in terms of the hydrolyzed neptunium(IV) species. (auth)

5887 VAPOR PRESSURE MEASUREMENTS ON THORIUM NITRIDES. Aronson, S.; Auskern, A. B. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. J. Phys. Chem., 70: 3937-41(Dec. 15, 1966). (BNL-10293).

Three nitrides of thorium were reported, ThN, Th_3N_4, and Th_2N_3. In recent literature, the existence of Th_3N_4 was questioned. Samples of thorium nitride were prepared by heating thorium metal in nitrogen at 500 to 900°C. The composition of the nitride determined from the weight change corresponded to the formula Th_3N_4. The x-ray diffraction pattern of the nitride was different from that reported for ThN or Th_2N_3. Vapor pressure measurements over the two-phase system ThN–Th_3N_4 were made at temperatures of 1450 to 1800°C. The nitrogen pressure ranged from 5 to 200 torr. The enthalpy and entropy changes calculated from the data for the reaction $6ThN(s) + N_2(g) = 2Th_3N_4(s)$ were −72.7 kcal/mole of N_2 and −32.7 eu/mole of N_2, respectively. (auth)

5888 THE ν_3 INFRARED BANDS OF $^{12}CH_4$ AND $^{13}CH_4$. McDowell, Robin S. (Los Alamos Scientific Lab., N. Mex.). J. Mol. Spectros., 21: 280-90(Nov. 1966). (LA-DC-8063).

The infrared spectrum of 92 mole % $^{13}CH_4$ was obtained over the region 2870 to 3130 cm^{-1} at a resolution of about 0.3 cm^{-1} and was compared with the spectrum of $^{12}CH_4$. The tetrahedral splitting was partly resolved and the splitting constants were determined by applying the theoretical treatments of Herranz and Hecht. With the aid of a partial analysis of the Q branch, and assuming a value for the ground-state rotational constant B_0, the molecular constants were obtained. Significant changes in going from $^{12}CH_4$ to $^{13}CH_4$ were observed for the following constants: $\Delta\nu_0 = -9.95$ cm^{-1}; $\Delta B_{eff}^0 = +0.0027$ cm^{-1}; $\Delta\alpha_3 = -0.0013$ cm^{-1}; $\Delta\zeta_3 = -0.0088$; as well as for some of the splitting constants. These changes are discussed and are shown to be generally in agreement with theoretical predictions using previously established force constants and harmonic frequencies. Expected vibrational frequency shifts, $\Delta\nu$, are tabulated for a number of vibrational modes; it is shown that analyses of $^{13}CH_4$ spectra will be useful in making assignments in the overtone region and may lead to more precise force constants for methane. (auth)

5889 POTENTIOMETRIC INVESTIGATIONS ON COMPLEX FORMATION OF Ce(III), Ce(IV), Th(IV), U(IV), AND CITRATE IN AQUEOUS SOLUTION. Nebel, Dieter; Urban, Gertraud (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Z. Phys. Chem. (Leipzig), 233: 73-84(1966). (In German).

With the help of p_H titrations and redox potential measurements stability constants for the citrate complexes of Ce(III), Ce(IV), Th(IV), and U(IV) were determined: for Ce(III), $K_1 = 6.6 \pm 0.7 \times 10^8$ and $K_2 = 1.7 \pm 0.2 \cdot 10^{12}$; for Ce(IV), $K_1 = 7 \times 10^{11}$ and $K_2 = 2.1 \times 10^{22}$; for Th(IV), $K_1 = 1 \times 10^{13}$ and $K_2 = 9.5 \times 10^{20}$; and for U(IV), $K_1 = 3.4 \times 10^{11}$ and $K_2 = 2.9 \times 10^{19}$. (tr-auth)

5890 INVESTIGATION OF Pu(IV)-LACTATE EQUILIBRIUM IN AQUEOUS SOLUTION. Nebel, Dieter (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Z. Phys. Chem. (Leipzig), 233: 62-72(1966). (In German).

Pu^{4+} forms complex compounds with lactate ions; in the lactate ion concentration region between 10^{-2} and 10^{-4}M the compound corresponds to the formula PuL_4. With the help of potentiometric and spectrophotometric measurements a stability constant of $K_4 = 1.5 \cdot 10^{16}$ could be determined for this compound. (tr-auth)

5891 CRYSTAL FIELD CALCULATION IN URANIUM DIOXIDE. Rahman, H. U.; Runciman, W. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys. Chem. Solids, 27: 1833-5(Nov.-Dec. 1966).

Recent neutron diffraction studies showed that UO_2 is anti-ferromagnetic below 30.8°K with an effective magnetic moment of about 1.8 Bohr magnetons/uranium atom. Electrostatic, spin-orbit, and crystal field matrices were diagonalized within the $5f^2$ configuration of the U^{4+} ion in a cubic crystal field. Energy levels were calculated for a set of parameters, which yield the value of 1.8 β for the ground state. The values of these parameters, in units of cm^{-1}, are: $F_2 = 191.4$, $F_4 = 33.83$, $F_6 = 3.98$, $\zeta_{5f} = 1796$, $A_4\langle r^4\rangle = -3300$, and $A_6\langle r^6\rangle = 200$. (auth)

5892 THE OXIDATION OF CARBANIONS. I. OXIDATION OF TRIARYL CARBANIONS AND OTHER TERTIARY CARBANIONS. Russell, Glen A.; Bemis, Alan G. (Iowa State Univ., Ames). J. Amer. Chem. Soc., 88: 5491-7(Dec. 5, 1966).

The rate of oxidation of triphenylmethane in dimethyl sulfoxide (80%)-t-butyl alcohol (20%) solution is shown to be equal to the rate of ionization of the hydrocarbon to the carbanion. The oxidation reaction is rate controlled by the ionization process. Some evidence is presented to indicate that the rapid process by which the carbanion is consumed is of a free radical or electron-transfer nature. The ionization of triphenylmethane in the solvent employed is first order in hydrocarbon and in potassium t-butoxide. The base appears to be completely dissociated in this solvent system. The deuterium isotope effect in the ionization is 9.5 at 25°C. The effects of structure and solvents on the products and rates of oxygenation of some other tertiary carbanions are considered. (auth)

5893 STUDIES ON SULFATE ESTERS. II. CARBOXYL GROUP CATALYSIS IN THE HYDROLYSIS OF SALICYL SULFATE. Benkovic, Stephen J. (Pennsylvania State Univ., University Park). J. Amer. Chem. Soc., 88: 5511-15(Dec. 5, 1966).

The pH-rate profile for the hydrolysis of salicyl sulfate revealed hydronium ion and intramolecular carboxyl group catalysis. In contrast the rate of hydrolysis of p-carboxyphenyl sulfate was accelerated only by hydronium ion. The acid-catalyzed hydrolysis of aromatic sulfates is viewed as an A1 mechanism on the basis of activation entropies and D_2O solvent isotope and substituent effects. Intramolecular carboxyl group participation is discussed in terms of general acid or specific acid nucleophilic catalysis and compared to other examples involving similar behavior including salicyl phosphate. (auth)

5894 THE MECHANISM OF THE DEHYDROCHLORINATION OF β-BENZENE HEXACHLORIDE. Hine, Jack; Weimar, Richard D. Jr.; Langford, Paul B.; Ramsay, O. Bertrand (Georgia Inst. of Tech., Atlanta. Ohio State Univ., Columbus). J. Amer. Chem. Soc., 88: 5522-5(Dec. 5, 1966).

The dehydrochlorination of β-benzene hexachloride by sodium methoxide in methanol-O-d yielded a trichlorobenzene mixture (containing about 87% 1,2,4 isomer) that contained 0.02 to 0.05 deuterium atom/molecule when the dehydrochlorination was stopped at 70% completion. This amount of deuterium is no more than would be expected to arise by deuterium exchange of the trichlorobenzene after its formation. It is therefore concluded that the dehydrochlorination does not involve an initial isomerization of β-benzene hexachloride to the δ isomer. An estimate of the rate constant to be expected for carbanion formation from β-benzene hexachloride under the dehydrochlorination conditions gives a value fairly near the observed rate constant for dehydrochlorination. It is therefore plausible that elimination proceeds via intermediate carbanion formation. However, it is also plausible that the reaction consists largely of a concerted cis elimination from a boat conformer. (auth)

5895 RELATIVE RATES OF BASE-CATALYZED ENOLIZATION OF 2-BUTANONE. Warkentin, J.; Tee, O. S. (McMaster Univ., Hamilton, Ont.). J. Amer. Chem. Soc., 88: 5540-3(Dec. 5, 1966).

Base-catalyzed enolization at the α carbons of 2-butanone in D_2O and in D_2O-dioxane mixtures was followed by nmr. In D_2O the reactivity of the methylene protons exceeded slightly that of the α-methyl protons for the catalyst OD^-. With $p\text{-}O_2NC_6H_4O^-$ and AcO^- the effect increased in that order. The accelerating effect of the β-CH_3 substituent can be accounted for in terms of a transition state that resembles enol and not enolate. (auth)

5896 SEARCH FOR HYDROGEN–DEUTERIUM EXCHANGE ON CLEAN ALUMINUM SURFACES. Dafler, James R. (Continental Oil Co., Ponca City, Okla.). J. Amer. Chem. Soc., 88: 5667-8(Dec. 5, 1966).

Aluminum films of high purity were exposed to hydrogen and deuterium mixtures under high pressure. No evidence of chemisorption of H_2 on Al at 273°K was found. Baked glass substrate brought about as much H_2–D_2 conversion as did the Al films. Aluminum film exposed, prior to dosing with H_2 and D_2 to water vapor for several minutes gave increased conversion. (D.H.M.)

5897 SOME PHYSICOCHEMICAL PROPERTIES OF $Na_2[UF_8]$. Peka, L.; Sedlakova, L.; Sykora, F. (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collect. Czech. Chem. Commun., 31: 4449-52(Nov. 1966). (In German).

The first phase of the two-stage decomposition of $Na_2[UF_8]$, the formation of $UF_6 \cdot 3NaF$ and of gaseous UF_6, was investigated. The crystallographic structure of the compound was determined and roentgenograms were obtained. (M.C.G.)

5898 INVESTIGATION OF THE REACTION OF URANIUM (VI) FLUORIDES WITH SOME SOLID FLUORIDES. Peka, I. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collect. Czech. Chem. Commun., 31: 4245-51(Nov. 1966). (In German).

Compounds which form in the reaction of UF_6 with LiF, NaF, KF, CsF, SrF_2, and AlF_3 at 80 to 200°C, and in some cases at higher temperatures, are described. It was established that with NaF at a UF_6 pressure of 1 kp/cm^2 $UF_6 \cdot 3NaF$ is formed to 80°C and at higher temperatures $UF_6 \cdot (2.24$ to $2.47)NaF$ is formed. KF and CsF react under the same conditions to 80°C to form $UF_6 \cdot 3KF$ and $UF_6 \cdot 3CsF$ and at higher temperatures to form $UF_6 \cdot 2KF$ and $UF_6 \cdot 2CsF$. LiF, SrF_2, and AlF_3 showed no tendency for the formation of these compounds. (tr-auth)

5899 SOLUBILITY OF SALTS FORMED BY QUATERNARY AMMONIUM BASES WITH TETRAVALENT ACTINIDE HEXANITRATE ANIONS. Nikol'skii, B. P.; Posvol'skii, M. V.; Markov, G. S. Radiokhimiya, 8: 114-15(1966). (In Russian).

The solubility of a series of salts of the type $R_2Me(NO_3)_6$, where R = quaternary ammonium bases and Me = actinides in the tetravalent form (Th, U, Np, and Pu), was investigated. These complexes are very soluble in water but separate from nitric acid solution (concentration 5 to 9 N HNO_3) in the form of crystalline precipitates. Increased temperature leads to an increase in solubility. The temperature coefficient for all thorium salts is approximately the same (1.3 to 1.5 per 10°). (J.S.R.)

5900 SCANDIUM SORPTION FROM WATER–ACETONE SOLUTIONS OF VARIOUS MINERAL ACIDS. Brykina, G. D.; Alimarin, I. P.; Belyavskaya, T. A. Radiokhimiya, 8: 110-12 (1966). (In Russian).

The ion exchange behavior of scandium was investigated in mixtures of mineral acids (H_2SO_4, HNO_3, and HCl) with acetone in a wide acidity range from 1 to 10 N. The results showed that for scandium in mineral acid solutions the cation and neutral forms are the most characteristic. The nature of the anion showed an appreciable effect on the sorption of the element. The addition of an organic solvent significantly increased the sorption of scandium (J.S.R.)

5901 CO-PRECIPITATION OF RADIOACTIVE ISOTOPES OF BARIUM AND STRONTIUM WITH LEAD SULFATES. Tot, B.; Gromov, B. V. Radiokhimiya, 8: 3-8(1966). (In Russian).

By studying the speed of the establishment of equilibrium, isothermal methods of coprecipitation, and the effects of multivalent ions on coprecipitation, it was established that during the coprecipitation of microquantities of barium and strontium with $PbSO_4$ by means of the gradual addition of the precipitant, adsorptive capture does not take place. The distribution coefficients λ and D during isomorphous coprecipitation of ^{140}Ba and ^{89}Sr with $PbSO_4$ were determined and it was established that under the given conditions the distribution of the microquantities follows the Doerner-Hoskins logarithmic law. (tr-auth)

5902 OLEFIN HYDROGENATION AND H_2-D_2. Rennard, Raymond J. Jr. Baltimore, Johns Hopkins Univ., 1966. 86p. Thesis.

Absorption of H_2 by Pd at −78°C results in the formation of a stable hydride with a H_2 equilibrium pressure of a few microns. The reaction of ethylene with Pd_2H is pseudo-first order in the H_2 content of the catalyst. The reaction of ethylene with Pd_2D follows the same kinetics and an inverse isotope effect is observed. The rate-controlling step in the reaction is probably the addition of absorbed H_2 to the adsorbed ethylene to form the half hydrogenated state. The presence of gas-phase hydrogen has little effect on the rate of reaction indicating that the hydrogen in the gas phase serves only to maintain or replenish the bulk Pd_2H, which then reacts with adsorbed ethylene. The pseudo first-order rate constant decreases as the initial H_2 content of the catalyst increases. The high-temperature absorption of H_2 reduces the activity of the catalyst at −78°C, probably through a reorganization of the surface layer of the Pd_2H. Activation energies for the reaction of ethylene with Pd_2H and Pd_2D were determined. The equilibration of H_2-D_2 over Pd_2H at −196 and −183°C was studied. At both temperatures the rate of equilibration decreased as the initial H_2 content of the catalyst increased. (Dissertation Abstr.)

Radiation and Nuclear Chemistry

Refer also to abstract 5747, 5767, 5834, 5835, 6839, and 7885.

5903 (AD–642794) RANGE AND DEPTH DOSE DISTRIBUTION OF LOW ENERGY CHARGED PARTICLES IN DOSIMETRY GLASSES. Becker, K. (Naval Radiological Defense Lab., San Francisco, Calif.). Oct. 21, 1966. 23p. (USNRDL-TR-1088). CFSTI $3.00 cy, $0.65 mn.

A method for direct determination of particle ranges and depth dose distributions in silver-activated phosphate glasses based on the successive removal of extremely thin surface layers from the exposed glass by chemical etching ("peeling") and measurement of the residual radiophotoluminescence between successive etchings is presented. Glass composition, etching chemicals, and etching speed can be varied within wide limits. The experimental technique, using YOKOTA-type dosimeter glasses and 28% NaOH at 60°C (etching speed 0.12 μ/min.) is described. As examples for the practical application of the method, measurements using several types of radiation sources (aqueous solutions of ^3H, ^{63}Ni and ^{35}S, solutions and thin and thick solid sources of ^{239}Pu, ^{237}Np and ^{238}U, monoenergetic protons, deuterons, and He^+ ions in a wide energy range) were made. Accuracy, possibilities, and limitations of the method are discussed. Possible sources of error are: discoloration of the glass because of very high surface doses; uncertainties in the determination of the etching speed; etching speed along charged particle tracks higher than the bulk etch rate for ions of very high LET. (auth)

5904 (IA-1082, pp 21-4) RADIOISOTOPE PRODUCTION. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

The production of ^{99m}Tc, neohydrin–^{197}Hg, carrier-free ^{35}S, and colloidal ^{198}Au is discussed. Progress was made toward the production of beta and gamma standard calibration sources for energy calibration and as quantitative standards. (P.C.H.)

5905 (N–66-21226) L FLUORESCENCE YIELDS OF GOLD AND URANIUM. Di Lazzaro, M. A.; Missoni, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). May 3, 1965. 40p. (ISS–65/11). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A simple procedure was used to measure some L-shell fluorescence yields. It consists of measuring the coincidence counting rate between X_K and X_L fluorescence photons emitted from a target struck by γ rays. Measured values of ω_{L_2}, ω_L, and ω_{KL}, related to uranium and gold, are reported and compared with similar values obtained by other authors. (auth)

5906 (NYO–3364-31) BETATRON IRRADIATION OF OXYGEN AT 31 MeV. Stroemme, Aksel (Norsk Radiumhospital, Oslo). [nd]. Contract AT(30-1)-3364. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Three different compounds of oxygen were irradiated with betatrons at an energy of 31 MeV: H_2O distilled, triple distilled, and tap water; pure H_3BO_3; and pure Al_2O_3. The production of four radioisotopes was noted: ^{14}O, ^{15}O, ^{13}N, and ^{11}C. The proportion of these at a dose of 200 R and an irradiation time of about 12 min and 30 sec was: $8.10^3 : 4.10^3 : 3 : 1$. (P.C.H.)

5907 (SC-RR-66-669) FLASH PHOTOLYSIS AND TIME RESOLVED MASS SPECTROMETRY: REACTION OF EXCITED IODINE ($^2P_{\frac{1}{2}}$) ATOMS IN THE DECOMPOSITION OF METHYL IODIDE. Meyer, Richard T. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1966. Contract AT(29-1)-789. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The flash photolysis of methyl iodide has been studied by time resolved mass spectrometry. Mixtures of CH_3I vapor with Ar, O_2, Kr, and N_2 at total pressures of 5 to 12 torr have been photolyzed with flash durations as short as 18 μsec. The ultraviolet light flux was approximately 3×10^{18} quanta/cm^2. A modified Bendix TOF mass spectrometer provided 1.4 μsec sampling intervals every 50 μsec. Overall decomposition of CH_3I was 20 to 75 percent, with the larger decompositions occurring in the absence of the added gases. I_2, CH_4, C_2H_6, C_2H_4, and some C_2H_2 are formed as final products. All systems show I_2 formation by two processes, one fast and one slow. The fast process occurs within a time interval of 75 μsec after the flash peak and accounts for approximately 50 percent of the total I_2 production. This rapid formation of I_2 cannot be explained in terms of a thermolecular recombination of atomic iodine nor in terms of an elevated temperature reaction between ground state iodine atoms and methyl iodide. It was concluded that excited, metastable $I(^2P_{\frac{1}{2}})$ atoms are produced in the primary decomposition. These excited atoms have sufficient energy (21.7 kcal/mole) to undergo the following reaction: $I(^2P_{\frac{1}{2}}) + CH_3I \rightarrow CH_3 + I_2 + 3$ kcal. This bimolecular reaction accounts for the rapid formation of molecular iodine. (auth)

5908 (STI-DOC-10/63) MANUAL OF RADIOISOTOPE PRODUCTION. Technical Reports Series No. 63. (International Atomic Energy Agency, Vienna (Austria)). July 1966. 446p. IAEA: $9.50; S 246,-; £ 3.7.0; F Fr 46,60; DM 38,-.

Technical and economic considerations that govern the planning and execution of an isotope program and experimental details of

isotope production processes are discussed. Topics common to all radioisotope processing, namely laboratory design, handling and dispensing of radioactive solutions, quality control, measurement, and radiological safety, are covered. Information on the more common radioisotopes, ^{82}Br, ^{58}Co, ^{51}Cr, ^{64}Cu, ^{18}F, ^{198}Au, ^{131}I, ^{59}Fe, ^{28}Mg, ^{24}Na, ^{32}P, ^{35}S, ^{90}Y, and ^{65}Zn, is given. Their nuclear properties are described, references to typical applications are given, and published methods of production are reviewed. Descriptions of the production processes used at several national atomic energy organizations are given in detail. (D.H.M.)

5909 (BNL-tr-108) DECOMPOSITION OF OZONE BY THE ACTION OF THE ALPHA PARTICLES. Capron, P. C.; Cloetens, R. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Bull. Soc. Chim. Belges, 44: 441-66 (1935). 30p. Dep. mn. JCL $2.60 fs, $1.10 mf.

The decomposition of ozone under the action of alpha particles in a glass container devoid of mercury and organic substances was studied. The ozonization of oxygen was performed in the same reaction vessel. Under the operating conditions used (quantity of ozone between 3 and 20 mm Hg and a total pressure in the neighborhood of 700 mm, and quantity of radon between 5 and 35 millicuries) the rate of ozone decomposition was proportional to its concentration. Ion production increased with increasing radiation intensity. This variation was in the opposite direction to that found in the radiochemical decomposition of H_2S and NH_3. (auth)

5910 KINETICS OF PROTON-TRANSFER REACTIONS. Barker, G. C.; Sammon, D. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nature, 213: 65-6(Jan. 7, 1967).

The application of pulse radiolysis to the study of the reaction between H_3O^+ and OH^- is reported. Pulse radiolysis of water and aqueous solutions produces transient changes in composition, and the subsequent relaxation of the system can be studied in various ways, including electrical conductivity measurements. The overall effect is sudden production of the ionic species H_3O^+, H_2O^-, and OH^-; the relaxation of the H_3O^+ concentration can be followed under appropriate conditions. Pure water and dilute aqueous ammonia were irradiated with 2.5-μsec pulses of 4-MeV electrons from a linear accelerator, and the change in electrical conductivity with time was recorded. The experimental technique is outlined, and the results discussed. Pseudo-first order kinetics were indicated. Rate constants are tabulated. Values obtained were appreciably lower than from other methods, and it was not possible to reconcile the results with those obtained using other techniques. (UK)

5911 LIGHT EMISSION AFTER PULSE RADIOLYSIS OF AQUEOUS SOLUTIONS OF DYES. Pruetz, W. (Univ., Freiburg i. B.); Sommermeyer, K.; Land, E. J. Nature, 212: 1043-4 (Dec. 3, 1966).

Argon-flushed aqueous solutions of four dyes (acriflavine, eosin, fluorescein, and rhodamine B) were found to emit light up to 100 μsec after a 2 μsec pulse of 4 MeV electrons. The time characteristics and total light output varied with dye concentration which ranged from 5×10^{-7} to 10^{-5} moles/l. The effects of hydrated electron and hydroxyl scavengers on the dyes (except eosin) were investigated. Mechanisms which might account for the delayed emissions are proposed. (J.G.B.)

5912 APPLIED RADIATION CHEMISTRY. Black, R. M. (British Insulated Callender's Cables Ltd., London). Rep. Progr. Appl. Chem., 50: 144-58(1965).

Recent progress is reviewed under the following headings: introduction, crosslinking of polymers, polymerisation of monomers, graft co-polymers, preparative radiation chemistry (chemonuclear processes), and radiation damage and protection. (UK)

5913 POLYMERIZATION IN THE SOLID STATE. Bamford, C. H.; Eastmond, G. C. (Univ. of Liverpool). Rep. Progr. Appl. Chem., 50: 472-9(1965).

Recent developments are reviewed under the following headings: introduction, molecular mobility, effects of stress, and topotactic polymerisation. Attention is given to work on irradiation polymerisation. (UK)

5914 PULSE RADIOLYSIS OF CRYSTALLINE ICE AND FROZEN CRYSTALLINE AQUEOUS SOLUTIONS. Shubin, V. N.; Zhigunov, V. A.; Zolotarevskii, V. I.; Dolin, P. I. (Inst. of Electrochemistry, Moscow). Nature, 212: 1002; 10035(Dec. 3, 1966).

The optical absorption spectra of crystalline ice and frozen crystalline aqueous solutions using electron pulse radiation was investigated to check the agreement between theoretical predictions and experimental results. Contrary to expectation, the absorption band for crystalline ice was found in the same region of the spectrum as that of liquid water. In the case for lithium perchlorate and potassium hydroxide solutions the reaction of disappearance of the unstable intermediate compound responsible for the absorption spectrum had first order kinetics. Curves showing the dependence of the rate constants of decay on temperature for the three cases in question had almost the same slope. This seems to indicate that decay results from the same process in all cases: a process with an activation energy of 6 ± 1 kcal/mole. The results do not agree with the solvated electron theory that is presently being developed. (P.C.H.)

5915 FREE RADICALS IN THE RADIOLYSIS OF BENZYL HALIDES. Brocklehurst, B.; Savadatti, M. I. (Sheffield Univ., Eng.). Nature, 212: 1231(Dec. 10, 1966).

The production of free radicals in α-bromo, α-chloro-, and α,α-dichlorotoluene by gamma radiation was studied by uv absorption spectroscopy. It was found that long periods of warming caused the spectra to disappear. A plausible explanation for this effect seems to be that $C_6H_5CH_2 \cdot Cl^-$ is first formed and the Cl^- escapes from the solvent cage on warming. (P.C.H.)

5916 TEMPERATURE DEPENDENCIES OF CORONA RESISTANCE OF POLYETHYLENE FILMS AND MAGNITUDE DISTRIBUTIONS OF CORONA DISCHARGES OF POINT-PLANEM ETHODE. Sakai, Takao; Ito, Tairo (Musashi Inst. of Tech., Japan). Denki Gakkai Zasshi, 86: 93-100(Jan. 1966). (In Japanese).

The temperature dependence of the corona resistance of irradiated polyethylene films (Hitalex for electrical use, degree of crystallinity 93%, thickness of 0.05 mm) was measured in dry air, hexafluorosulfide, and nitrogen. In the process of corona erosion of polyethylene in air at low temperatures, the concentration of ozone is increased by a discharge. Below room temperature, therefore, the oxidation by ozone precedes other phenomena in the erosion. In the temperature region above room temperature, the erosion is accelerated by increases in temperature, and the corona resistance exhibits a maximum for the temperature. In a nitrogen atmosphere, the corona resistance decreases with increase of the temperature and shows no maximum in the temperature curve. In hexafluorosulfide, the corona resistance measured with the magnitude of a discharge is very small and has no maximum with temperature. The corona resistance of irradiated polyethylene shows a behavior dependent on the condition and temperature of irradiation. But no evidence was obtained that its corona resistance was improved by irradiation. The relationship between the magnitude of a discharge and the distribution of discharge frequency, which was obtained by measurement of the corona resistance by the concentration method, and the change of distribution at high voltages are explained by means of the relation between the time lags of sparks and the figures of discharges, obtained by changing the gap voltage. (NSA of Japan)

5917 PULSED RADIOLYSIS OF GASES: DIRECT OBSERVATION OF ^1S CARBON ATOMS IN CARBON DIOXIDE, CARBON MONOXIDE, AND METHANE. Meaburn, G. M.; Perner, D. (Centre d'Etudes Nucleaires, Saclay, France). Nature, 212: 1042(Dec. 3, 1966).

The reactions of free carbon atoms with both organic and inorganic molecules have been extensively studied in the gas phase. By means of pulsed radiolysis, the optical absorption of a transient species in CO_2 irradiated by electrons was observed. The spectrum is assigned to a carbon atom in the ^1S state, and the same absorption has been seen in irradiated CO and CH_4. A pulsed 250-kV electron source producing single pulses of about 0.2 μsec in duration was used. Spectra were recorded with the aid of a Hilger medium spectrograph using Ilford HP3 plates. Lifetimes of the transient absorption were determined from optical density measurements made at different intervals of time after the electron pulse. (W.D.M.)

5918 CROSSLINKING OF POLYPROPYLENE. Hatton, J. R.; Jackson, J. B.; Miller, R. G. J. Polymer, 8: 41-7(Jan. 1967).

A study was carried out on the formation of networks in atactic and isotactic polypropylene by irradiation with uv light of samples swollen in a solution of benzophenone in allyl acrylate. Network formation only occurs when allyl acrylate is present and infrared spectra of the networks suggest that both double bonds have reacted. The concentration of acrylate units in atactic and isotactic polymer networks were measured by infrared absorption. Swelling measurements, though of doubtful validity due to the high crosslink density, support the view that each molecule of allyl acrylate is associated with one crosslink and the effective link must be the ester linkage, since monofunctional compounds such as allyl acetate are ineffective in network production. (auth)

5919 INVESTIGATION OF THE INFLUENCE OF X RAYS ON THE ELECTRIC CONDUCTIVITY OF LIQUID ORGANIC PHOTOCONDUCTORS. Kopylov, Yu. A.; Trofimova, T. N. (Dnepropetrovsk Construction Engineering Inst., USSR). Izv. Vyssh. Ucheb. Yaved., Fiz., No. 1, 85-92(1966). (In Russian).

The character of the metastable electron attachment, which causes photoconductivity in liquid organic semiconductors based on diethyl ether into which halide derivatives of benzene, methane, and other substances are introduced, was investigated. The investigated liquids were exposed to x radiation with a maximum near a wavelength 1.5 Å, and the resistance of the liquid was measured. Since the resistance of the exposed cell increased by thousands of times, the conductivity of the cell itself could be neglected. The x-ray exposure did not influence the conductivity of diethyl ether or the halide-substituted methanes or their solutions in the diethyl ether. The conductivity of chlorobenzene and bromobenzene increased on irradiation and returned to the earlier value after the removal of the excitation. The results showed that the only liquids whose conductivity changed as a result of exposure to the x rays are those containing molecules with a benzene ring. On the basis of the assumption that the primary cause of the change in conductivity are Compton electrons, the variation of the conductivity under the influence of x rays was compared with the variation of photoconductivity in these systems. It was concluded on the basis of this comparison that the electrons can become metastably fixed both to molecules of the halide derivatives of methane and benzene and to the molecules of the diethyl ether. Several models are proposed to explain these phenomena. While the variation of the resistivity under the influence of the exposure had a complex pattern, it was fully reproducible. The laws governing the photoconductivity and the change in conductivity under x-ray exposure were interpreted from the point of view of the following mechanisms: ionization of molecules, production of carriers, carrier motion, and carrier recombination. A kinetic equation was derived by a method proposed earlier to take into account the simultaneous occurrence of all these processes. This equation was found to fit the experimental data. (ATD)

5920 IONIZATION AND DISSOCIATION OF ETHANE BY ELECTRON IMPACT. MASS SPECTRA AND EXCHANGE PHENOMENA IN C_2H_6, C_2H_5D, CH_3CD_3, AND C_2D_6. Dor, L.; Collin, J. E.; Longree, J. (Univ., Liege). Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 518-46(1966). (In French).

The mass spectra and appearance potentials of C_2H_6, C_2H_5D, CH_3CD_3, and C_2D_6 were measured, in order to study the dissociation processes of ethane under electron impact. Special attention was drawn to the exchange phenomena occurring between hydrogen and deuterium in CH_3CD_3. This exchange makes difficult the study of dissociation processes. Two theoretical explanations were previously given for the exchange phenomena, and their relative merits for the interpretation of exchange mechanisms in ethane are discussed. Appearance potentials show that the activation energy of exchange is small. Some experimental data suggest that the rate of exchange in $CH_3CD_3^+$ could be higher than 10^{15} sec^{-1} and lower than 10^{20} sec^{-1}, and that exchange might also happen in fragment ions such as $CH_2CD_2^+$. Some isotope effects resulting from the substitution of hydrogen by deuterium were observed. (auth)

5921 RADICAL INDUCED CATIONIC POLYMERIZATION. Okamura, S.; Takakura, K.; Hayashi, K. (Kyoto Univ.). Pure Appl. Chem., 12: 387-401(1966).

Results are reported for a comparison of the benzoyl peroxide induced cationic polymerization with the gamma and ultraviolet radioinduced polymerization of cyclic esters and ethers with or without various additives. Studies were made using β-propiolactone, diketene, 3,3-bis(chloromethyl)oxetane, trioxane, and tetroxane. A reaction mechanism is proposed for the free radical induced cationic polymerization. (J.G.B.)

5922 STRUCTURE OF THYMINE PHOTO-DIMER. Blackburn, G. M.; Davies, R. J. H. (Cambridge Univ., Eng.). J. Chem. Soc. (C), No. 23, 2239-44(1966).

The structure and stereochemistry of thymine dimer, obtained by ultraviolet irradiation of a frozen, aqueous solution of thymine, was determined by its transformation into an isomer shown to be a derivative of 3,5,9-triazatricyclo-[5,3,0,$0^{2,6}$]decane of cis-syn-cis configuration. [auth]

5923 RADIATION POLYMERIZATION IN THE SOLID PHASE WITH BREAKING OF THE RING. Scrivener, J. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 62, Suppl., 6-12(Nov.-Dec. 1966). (In French).

Solid-phase radiation polymerization with breaking of the ring in heterocyclic compounds is discussed. The principal results obtained on a world-wide basis are reviewed. The mechanism of the radiation polymerization is illustrated on trioxane. (J.S.R.)

5924 EXCITED SPECIES OF GASES PRODUCED IN THE NUCLEAR REACTOR. Morse, F.; Harteck, P.; Dondes, S. (Rensselaer Polytechnic Inst., Troy, N. Y.). Radiat. Res., 29: 317-28(Nov. 1966).

Emission spectra of gases nitrogen, helium, and argon (contained in quartz vessels) were obtained by exciting the gases with fission fragments in a nuclear reactor. The quartz vessels themselves, on irradiation with mixed pile radiation and fission fragments, emitted a broad intense continuum extending throughout and apparently beyond the wavelength region examined (from >6700 to <2400 A). This continuum was superimposed on the spectra produced, making identification of weak bands or lines very difficult. However, the shorter wavelengths of this continuum may have photochemical effects on certain systems. The spectra obtained from the gases are qualitatively the same as those produced with polonium-210α-particles. The relative intensities, however, of the light-emitting ion-neutral mechanisms compared to direct excitation and collisions of the second kind appear to be greater for fission fragments than for ^{210}Po α particles. (auth)

5925 PREDICTION OF RADIATION EFFECTS ON REACTOR WATER AND SOLUTIONS. Jenks, G. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 382(Oct.–Nov. 1966).

5926 MEASUREMENT OF THE APPARENT KINETICS ORDER OF RADIOLYSIS AND THE FAST-NEUTRON EFFECT IN TERPHENYL IRRADIATIONS. Mason, Edward A.; Timmins, Tom H.; Morgan, Dean T.; Bley, William N. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 9: 404-6(Oct.–Nov. 1966).

5927 LET EFFECTS IN CHARGED-PARTICLE AND FAST-NEUTRON RADIOLYSIS OF AQUEOUS SOLUTIONS. Faw, Richard E. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc., 9: 601-2(Oct.–Nov. 1966).

5928 A COMPARISON OF THE RADIATION-INDUCED REACTION WITH PHOTOCHEMICAL AND THERMAL REACTIONS. I. THE RADIATION-INDUCED ISOMERIZATION OF o-NITROBENZALDEHYDE IN THE SOLID STATE. Sugimori, Akira; Nakata, Koichi; Hirai, Hachiro (Sophia Univ., Tokyo). Bull. Chem. Soc. Jap., 39: 1613-15(Dec. 1966).

The radioinduced reaction of o-nitrobenzaldehyde in the solid state was investigated. Isomerization to o-nitrosobenzoic acid preferentially took place. This suggests that γ irradiation produces effectively the excited o-nitrobenzaldehyde which is identical with that produced by ultraviolet irradiation. (auth)

5929 THE EFFECTS OF THE TEMPERATURE ON THE γ-RADIATION-INDUCED POLYMERIZATION OF ETHYLENE. Machi, Sueo; Hagiwara, Miyuki; Gotoda, Masao; Kagiya, Tsutomu (Japan Atomic Energy Research Inst., Gunma). Bull. Chem. Soc. Jap., 39: 2696-2702(Dec. 1966).

The gamma radioinduced polymerization of ethylene was carried out over the wide range of temperature from 30 to 200°C at pressure ranging from 100 to 400 kg/cm^2 and at dose rates from 2×10^3 to 4×10^5 rad/hr. It was found that the rate of polymerization is rapidly accelerated at 30°C, that the degree of acceleration decreases with an increase in the reaction temperature, and that above 100°C the rate is independent of the time. It was correspondingly found that the molecular weight of the polymer increases with the reaction time, at 30°C, that its increment for a unit of time decreases with an increase in the temperature, and that the molecular weight is independent of the time above 100°C. From a kinetic study it was concluded that the rate of the termination reaction, which is almost eliminated at 30°C, increases with the temperature and attains a value comparable to that of initiation above 100°C. The dose rate exponents of the polymerization rate and molecular weight were found to vary with the reaction temperature. Under a constant pressure, the polymer yield was found to decrease with the temperature from 30 to 60 to 80°C, and then to increase at high temperatures from 80 to 200°C. On the other hand, the molecular weight of the polymer simply decreases with the temperature from 30 to 200°C. The chain transfer reaction is considered to be almost negligible at 30 to 70°C. The number of polymer chains for a constant reaction time and monomer concentration is independent of the temperature from 30 to 70°C, while it increases with the temperature from 70 to 200°C. The effects of pressure on the polymer yield and molecular weight were also investigated at 140°C. (P.C.H.)

5930 THE RADIOLYSIS OF CRYSTALLINE OXALATO METAL COMPLEXES. THE EFFECTS OF COORDINATING METAL IONS ON THE RADIOLYSIS OF OXALATE. Sugimori, Akira (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Jap., 39: 2583-8(Dec. 1966).

Coordinated oxalates in metal complexes are more reactive under γ irradiation than are ionic oxalates. This suggests that the covalency between the metal ion and the ligand in oxalato metal complexes promotes the reactivity of the ligand. The reaction of the ligand is also affected by the central metal ions. In $K_3[Co(C_2O_4)_3] \cdot 3H_2O$ and $K_3[Fe(C_2O_4)_3] \cdot 3H_2O$, the coupled reduction of central metal ions with the oxidative decomposition of

the ligand to carbon dioxide occurs at relatively high G-values. In $K_3[Cr(C_2O_4)_3] \cdot 3H_2O$, the redox reaction of the central metal ion is small and the ligand decomposes into carbon dioxide and carbon monoxide. In $K_3[Al(C_2O_4)_3] \cdot 3H_2O$, the formation of glyoxal and formic acid instead of carbon monoxide is significant. (auth)

5931 MECHANICAL HARDENING OF ROCK SALT WITH γ RADIATION. Gorski, Walter; Heller, Siegfried (Max-Planck-Institut fuer Experimentelle Medizin, Goettingen, Ger.). Z. Naturforsch., 21a: 1522(Sept. 1966). (In German).

Samples of rock salt were exposed to γ radiation from a 5000 C source for 8.16, 81.6, and 816 hrs. The hardness was determined in Vickers numbers and compared with the results obtained from x radiation. The hardness increased with irradiation time, but x radiation gave higher hardness values. (J.S.R.)

5932 QUENCHING OF THE RADIATION LUMINESCENCE OF A LIQUID SCINTILLATOR BY THE RADIOLYSIS PRODUCTS OF BENZENE. Starodubtsev, S. V.; Gurskii, M. N.; Tsoi, A. N. Dokl. Akad. Nauk Uz. SSR, 22: No. 2, 21-4(1965). (In Russian).

The effects of the products from the gamma radiolysis of benzene in the presence of oxygen on the luminescence of the benzene–5% p-terphenyl liquid scintillator was studied. The radioinduced light yield of the scintillator was decreased. Since similar results were shown when the radiolytic products were added to pure benzene, it was concluded that the effect was due to the radiolysis products rather than the activator (p-terphenyl). When benzene was irradiated in N_2, the luminescence of the benzene–p-terphenyl scintillator was not quenched. When the equation $F = [(x_0/x)-1]$ 1/C was used, with F the effectiveness of transfer of energy in quenching, x_0 the light yield in the absence of the quenching substance, x the light yield in the presence of the quenching substance, and C the concentration of the substance (which at the dose of radiation applied was 1.6×10^{-3} mole/l), a value of F = 600 l/mole was obtained. (D.H.M.)

5933 EXCITATION OF THE FLUORESCENCE OF AQUEOUS DYE SOLUTIONS BY X RAYS AND ITS DEPENDENCE ON LET. Sommermeyer, K.; Pruetz, W. (Univ., Freiburg i. B.). Z. Naturforsch., 21a: 1081-4(July 1966). (In German).

The fluorescence of aqueous dye solutions produced by x radiation showed, on addition of quenching, nonself-fluorescing substances, a completely different behavior from fluorescence produced by uv. It is probable that an essential part of the fluorescence comes about by contamination with hydrated electrons and positive dye ions. (tr-auth)

5934 MOLECULAR IONS. VI. ELECTRONIC ABSORPTION AND ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF MOLECULAR IONS OF CONJUGATED DIENES AND ALLYL RADICALS. Shida, Tadamasa; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Amer. Chem. Soc., 88: 5371-6(Dec. 5, 1966). (COO-38-499).

Positive and negative molecular ions of butadiene and several homologs were prepared at –196°C in γ-irradiated sec-butyl chloride and methyltetrahydrofuran glasses, respectively. Positive and negative ions have similar absorption spectra, as alternant hydrocarbons should. Values of λ_{max} for the lowest two absorption bands were in good agreement with theoretical prediction based on simple Hückel molecular orbital theory. Band maxima of anions were not sensitive to substituent alkyl groups, whereas those of cations were red-shifted as the number of substituent methyl groups increased. In alcoholic matrices butadiene anions formed allylic radicals by the reaction $CH_2=CHCH=CH_2^- + ROH \rightarrow CH_2=CH\dot{C}HCH_3 + RO^-$, confirmed by EPR. (auth)

5935 STRUCTURE OF POLYVINYLIDENEFLUORIDE OBTAINED BY RADIATION AND CHEMICAL POLYMERIZATION. Galperin, E. L.; Dubov, S. S.; Volkova, E. V.; Mlenik, M. P.; Bulygina, L. A. Vysokomol. Soedin., 8: 2033(Nov. 1966). (In Russian).

A comparison was made of polyvinylidenefluoride obtained by radioinduced polymerization in the gaseous phase in which the α-form (cis-conformation) occurs and chemical polymerization in which mainly the β-form (o-trans-conformation) occurs. (auth)

5936 GRAFT POLYMERIZATION OF STYRENE ON POLYPROPYLENE. Kurilenko, A. I.; Danilov, E. P.; Temnikovskii, V. A. Vysokomol. Soedin., 8: 2024-31(Nov. 1966). (In Russian).

The graft polymerization of styrene from gaseous phase on polypropylene fibers previously γ irradiated in vacuo was studied. Proposals concerning the mechanism of the process and structure of the grafted fibers were based on a comparison of the results of the kinetics of sorption, graft copolymerization, and radical decay in the course of polymerization along with data from ir-spectroscopy and thermomechanic measurements. Oriented structures of grafted polystyrene were formed directly on synthesis. (auth)

5937 RADIATION INDUCED POLYISOBUTENE DEGRADATION IN HEPTANE SOLUTION. Lukhovitskii, V. I.; Tsingister, V. A.; Sharadina, N. A.; Karpov, V. L. Vysokomol. Soedin., 8: 1932-5(Nov. 1966). (In Russian).

During the radioinduced degradation of polyisobutene in heptane solution at room temperature the radiation chemical yield G of chain scission was increased with dilution attaining maximum of 21 scissions per 100 eV at a polyisobutene concentration of about 6%. The results obtained do not confirm a previous proposal that the decisive role on G-value at polyisobutene degradation is produced by the cell-effect. (auth)

5938 KINETICS OF ACCUMULATION OF FREE RADICALS IN IRRADIATED POLYVINYLCHLORIDE. Tikhomirov, L. A.; Buben, N. Ya. Vysokomol. Soedin., 8: 1881-5(Nov. 1966). (In Russian).

The kinetics of accumulation of free radicals during chloroethylene polymer irradiation with fast electrons with energy of 1.6 MeV in temperature range 100 to 318°K was studied by means of ESR. The limit in radical concentration in the irradiated polymer does not depend on the dose rate and slowly decreases with temperature growth. Under irradiation radicals decay on the first order reaction with constant k proportional to dose rate $j,k = k_{ij}$. Temperature dependence of k_1 corresponds to the change of effective activation energy from 0.3 kcal/mole at 100 to 200°K to 2 kcal/mole at 200 to 318°K. The different mechanisms of radical decay in the irradiation field are discussed. (auth)

5939 EFFECT OF IRRADIATION ON THE THERMAL CONDUCTIVITY OF UO_{2-x}, UO_2, AND UO_{2+x} AT 60 DEG C. MacEwan, J. R.; Stoute, R. L. J. Nucl. Mater., 21: 70-6(1966).

Higher thermal conductivity for UO_{2-x} than for UO_2 in the temperature range 300 to 1400°C was reported previously. This difference was not confirmed in-pile at low irradiation exposures. An improvement noted at higher exposures was consistent with either UO_{2-x} being more resistant than UO_2 to irradiation damage at low temperature, or with an irradiation-induced enhancement of conductivity in UO_{2-x} above 400°C. Results confirm equal conductivities for unirradiated $UO_{1.97}$ and UO_2 at 60°C. Both conductivities were reduced by 30% following an irradiation exposure to 10^{17} fissions/cm³ at a temperature below 150°C. Thus, since both UO_2 and UO_{2-x} were equally affected, there must be an irradiation-induced enhancement of conductivity in UO_{2-x} above 400°C. The effect may be associated with the solution of uranium in the lattice. (auth)

5940 ESR SPECTRA OF GAMMA-IRRADIATED COTTON CELLULOSE I AND II. Arthur, Jett C. Jr.; Mares, Trinidad; Hinojosa, Oscar (Southern Regional Research Lab., New Orleans). Textile Res. J., 36: 630-5(July 1966).

The electron spin resonance (ESR) spectra of purified fibrous cotton cellulose I and cotton cellulose II (mercerized) irradiated with γ radiation from a ^{60}Co source indicated that the products contained relatively stable free radicals. The ESR spectrum of irradiated cellulose I consisted of 3 lines, and that of irradiated cellulose II of 5. The principal lines of both spectra occurred at about the free electron value, and symmetry of the spectra indicated equal interaction of hydrogen nuclear spins with the free radical. Explanations are offered for the formation of radicals that give rise to the principal lines in each spectrum. (TSS)

5941 RADIOLYSIS OF NITROUS OXIDE SATURATED SOLUTIONS: EFFECT OF SODIUM NITRATE, 2-PROPANOL, AND SODIUM FORMATE. Mahlman, H. A. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Phys. Chem., 70: 3983-7(Dec. 15, 1966). (ORNL-P-2369).

The ^{60}Co γ radiolysis of aqueous N_2O-saturated $NaNO_3$ solutions gave the yield of reducing radicals not producing molecular hydrogen as 2.95 and $k(NO_3 + Red)/k(N_2O + Red)$ as 1.44. Hydrogen yields observed in the ^{60}Co γ radiolysis of aqueous N_2O-saturated 2-propanol solutions are interpreted as arising from the G_{H_2} from the radiolysis of N_2O-saturated water and determined to be 0.34, the H atom abstraction of hydrogen from the organic solute and evaluated as $G_H = 0.61$, and a "direct effect" equal to 0.54[2-propanol]. Similar treatment of the sodium formate data evaluates $G_H = 0.57$ and the "direct effect" as 0.16[sodium formate]. The simultaneously measured nitrogen yields are constant, indicating that the H atoms do not reduce N_2O to N_2 in aqueous N_2O-saturated solutions. (auth)

5942 REACTION OF THE HYDRATED ELECTRON WITH CARBON MONOXIDE AS STUDIED BY PULSE RADIOLYSIS. Raef, Y.; Swallow, A. J. (Christie Hospital, Manchester, Eng. Holt Radium Inst., Manchester, Eng.). J. Phys. Chem., 70: 4072-3(Dec. 15, 1966).

Evidence from pulse radiolysis indicated that the reaction of hydrated electrons with CO produces a hydrated formyl radical

in an ionized or neutral form. A 4-MeV electron linear accelerator was used as the radiation source. The reactions are $(H_2O)^- + CO \rightarrow H\dot{C}(OH)O^-$ and $(H_2O)^- + CO + H^+ \rightarrow \dot{C}H(OH)_2$. (M.C.G.)

5943 RADIATION-INDUCED ADDITION OF METHYLSILANE AND DIMETHYLSILANE TO ETHYLENE. A GAS-PHASE IONIC REACTION. Lampe, F. W.; Snyderman, J. S.; Johnston, W. H. (Johnston Labs., Inc., Baltimore). Contracts AT(30-1)-3655; AT(30-1)-2901. J. Phys. Chem., 70: 3934-7(Dec. 15, 1966).

Methylsilane and dimethylsilane undergo radioinduced addition to ethylene with the formation of telomeric products, 1:1 and 1:2 telomers being observed. At 50°C, G(1:1) values of 38 and 15 for methylsilane and dimethylsilane, respectively, were observed for a 3:1 reactant ratio of silane to ethylene. G(1:1) values, in the case of methylsilane, of several hundred were observed at temperatures up to 250°C. Nitric oxide inhibited these yields only slightly while NH_3 was a more efficient inhibitor. These facts plus an observed temperature dependence corresponding to about 1 kcal/mole strongly suggested that the chain-reaction-forming telomer is ionic. (auth)

5944 THE RELATION BETWEEN THE ENERGY YIELDS FROM RADIOCHEMICAL FORMATION OF OZONE AND NITROGEN OXIDATION. Dmitriev, M. T. Zh. Fiz. Khim., 40: 2729-34(Nov. 1966). (In Russian).

A direct ratio, $G(O_3)/G(NO_2)$, was determined in nitrogen oxidation with a minimum of products, which was achieved by rapidly passing the nitrogen–oxygen mixture through an irradiation zone followed by deposition of the products on a cooled surface. O_3, NO_2, and N_2O were obtained as reaction products. The ratios of oxygen concentration to nitrogen concentration and yields of ozone and nitrogen oxide as a function of the molar fraction of oxygen are given. When $[O_2]/[N_2] = [1.5G(O_3) + G(NO_2) + 0.5G(N_2O)]/[0.5G \times (NO_2) + G(N_2O)]$ the yield ratio for the mixture of 10% N_2 + 90% O_2 is $[O_2]/[N_2] = 18.7$. With increased molar oxygen fraction from 0.1 to 0.9 the ratio of the oxygen concentration to nitrogen increased 3.44 times and the yield ratio 4.2 times. With increasing molar oxygen fraction $G(O_3)$ increased reaching 8.5 molecules/100 eV. Observations of radioinduced ozone formation in a nitrogen–oxygen system revealed a sensitization reaction produced by transmission of the energy absorbed by the nitrogen to the oxygen molecules. (R.V.J.)

5945 RADIOCHEMISTRY OF PERCHLORIC COMPOUNDS. VI. RADIOLYSIS OF SOLID PERCHLORATES. Wang, Weng-Hsin; Bugaenko, L. T.; Belevskii, V. N. Zh. Fiz. Khim., 40: 2764-70(Nov. 1966). (In Russian).

Studies of $NaClO_4$ and $NaClO_4 \cdot H_2O$ γ radiolysis at −196 to 20°C and $Ba(ClO_4) \cdot 3H_2O$ and $Mg(ClO_4)_2$ at room temperature showed that ClO_3^- is the basic product of ClO_4^- ion radiolysis. Curves are given of concentrations of the reduction products ClO_2, Cl^-, ClO^-, and ClO_2^-. The yield of chlorine ions is proportional to the electron-cation fraction due to energy transmission from cation to anion. Radiolysis mechanisms of perchlorate ions in solid salts are discussed. (R.V.J.)

5946 FORMATION AND TRANSFORMATION OF PEROXIDE COMPOUNDS DURING RATIOOXIDATION OF HYDROCARBONS. Romantsev, M. F.; Saraeva, V. V. (Moscow State Univ.). Zh. Fiz. Khim., 40: 2798-2804(Nov. 1966). (In Russian).

An analysis of radioinduced oxidation of n-heptane and isooctane revealed certain phase regularities in peroxide compound formation during which dialkyl peroxides are secondary oxidation products produced by hydrogen peroxide conversion with simultaneous formation of alcohols. Observations of the irradiated systems uncovered certain competitive tendencies between hydrogen peroxide and oxygen for the capture of radical products of hydrocarbon radiolysis. The mechanisms of reactions based on the assumption that primary radicals vary according to excitation energies were analyzed. (R.V.J.)

5947 EPR METHOD FOR INVESTIGATION OF ^{60}Co γ RADIATION EFFECTS ON ANION EXCHANGE RESINS. Karpukhina, T. A.; Kiseleva, E. D.; Chmutov, K. V.; Glazunov, M. P. (Inst. of Physical Chemistry, Academy of Sciences, USSR). Zh. Fiz. Khim., 40: 2849-53(Nov. 1966). (In Russian).

Kinetics of radical concentration during γ irradiation of AB-17 and AB-18 resins and styrene copolymer with divinylbenzene were investigated and radical yield per 100 eV was computed. Stability of radicals formed at various temperatures and on prolonged storage was studied. An attempt was made to interpret the formation of various radicals and the variability of radio-resistance of various resins was confirmed. (R.V.J.)

5948 MOLECULAR IONS. VII. POSITIVE IONS OF OLEFINS IN γ-IRRADIATED ORGANIC GLASSES. Shida, Tadamasa; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Amer. Chem. Soc., 88: 5376-80(Dec. 5, 1966). (COO-38-504).

Vinylene- and vinylidene-type olefins appear to form their molecular cations in γ-irradiated alkyl chloride or alkane glass. Cations of vinyl-type olefins apparently react completely with solvent molecules. Molecular cations of the first two types of olefin have a broad absorption band at about 600 to 800 mμ which was assigned to a transition of a σ electron to the half-occupied π orbital of the ions. λ_{max} of the cation band shifts noticeably depending on the number and position of alkyl groups adjacent to the ethylenic bond. In pure γ-irradiated olefin glasses, positive charge migrates to solute molecules efficiently. (auth)

5949 RADICAL FORMATION IN THE RADIOLYSIS OF BRANCHED HYDROCARBONS. Holroyd, Richard A. (Atomics International, Canoga Park, Calif.). J. Amer. Chem. Soc., 88: 5381-6(Dec. 5, 1966).

The individual alkyl radical yields in irradiated 2,4-dimethylpentane and 2,2,4-trimethylpentane were measured with the ^{14}C labeled methyl radical "sampling" technique. Certain of the fragment alkyl radical yields from some branched hexanes and 2,3,4-trimethylpentane are reported. Fragmentation, which represents only a small fraction of the over-all radical yield in n-alkanes, becomes more important in branched alkanes, accounting for 48% of the total in 2,4-dimethylpentane and 64% in 2,2,4-trimethylpentane. This dependence of the fragment radical yields on molecular structure can be expressed by a single empirical relationship, $G(R) = (1.0C_1 + 2.8C_2 + 8.6C_3 + 29C_4)/(n-1)^2$, where n is the number of carbon–carbon bonds and the C_i's are the number of bonds (whose cleavage leads to the radical R) with i adjacent carbon–carbon bonds. As a corollary to the above the bond most likely to break in a molecule is the one with the most adjacent carbon–carbon bonds. A correlation of radical yields with the electron distribution in the highest occupied molecular orbital of alkanes is noted. The yield of parent-minus-hydrogen radicals decreases with increased branching of the molecule. The removal of a secondary hydrogen atom is more likely than removal of a primary hydrogen atom for these alkanes. The tertiary hydrogen atoms are less likely to be removed than the secondary in primary processes, a fact which is attributed to steric hindrance. Such an effect would be expected if the parent-minus-hydrogen radicals are formed in a bimolecular step. Evidence is presented to show that in the case of 2,2,4-trimethylpentane about 40% of the radicals formed initially react with radicals in the spurs. (auth)

5950 LOCALIZATION OF ENERGY IN RADIOLYSIS OF SOLUTIONS. V. FORMATION OF HYDROGEN AND HYDROGEN CHLORIDE IN TERNARY MIXTURES OF BENZENE, CYCLOHEXANE, AND CARBON TETRACHLORIDE. Urban, J.; Bednar, J. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collect. Czech. Chem. Commun., 31: 4221-37(Nov. 1966).

In radiolysis of ternary mixtures of benzene, cyclohexane, and carbon tetrachloride several mechanisms participate, such as capture of hydrogen atoms and electrons, transfer of the positive charge from carbon tetrachloride to hydrocarbons, and energy transfer in the same direction, partly connected with ionization of hydrocarbons. The high yields of hydrogen chloride show that both hydrocarbons investigated can decompose primarily with yields of about 10 molecules/100 eV. (auth)

5951 γ-RADIOLYSIS OF FERROCENE IN CYCLOHEXANE AND OF AQUEOUS SOLUTIONS OF FERRICINIUM SULPHATE. Blackburn, R.; Kabi, A. (Royal Military Coll. of Science, Shrivenham, Eng.). Chem. Commun., No. 23, 862-4(Dec. 7, 1966).

Factors involved in the ability of ferrocene (dicyclopentadienyliron) to reduce radiolysis yields in cyclohexane is discussed. The gamma radiolysis of aqueous solutions of ferricinium sulfate was investigated. It is suggested that the reduction in yields was due to a combination of factors: the aromatic character of ferrocene, positive charge transfer effects, and radical scavenging effects. Ferricinium sulfate was irradiated to doses up to 0.48 Mrad in air equilibrated and deaerated solutions. Results showed a lower yield of ferrocene in the presence of oxygen; this can be accounted for by the scavenging of hydrogen atoms. (D.H.M.)

5952 OPTICAL STUDIES IN X-IRRADIATED HIGH PURITY SODIUM SILICATE GLASSES. Mackey, J. H.; Smith, H. L.; Halperin, A. (Mellon Inst., Pittsburgh). J. Phys. Chem. Solids, 27: 1759-72(Nov.-Dec. 1966).

Optical processes in x-irradiated sodium silicate glasses, mostly of composition $Na_2O \cdot 2.5\ SiO_2$, were studied between 77 and 650°K. Seven color centers were identified from optical absorption or emission peaks and classified as trapped electrons or holes. From changes in colorability, it was concluded that some defect concentrations could be modified by melting in graphite instead of platinum, by varying melting temperature, or by subsequent annealing above 550°C. At 77°K, irradiation produced a strong absorption band of trapped electrons (the E_1^- band) which was peaked near 680 mμ (in sodium glasses) and had a long tail extending into

the near uv. The E_1^- centers, which showed a continuous range of thermal stabilities (and corresponding absorption peak shifts), are regarded as formed by electron trapping at a local concentration of the Na^+ ions in the interstices of the glass network. A distinction was made between E_1^- centers and E_2^- centers, which have similar optical properties but higher thermal stabilities; these latter centers were enhanced in glasses melted under reducing conditions. During thermal and light bleaching of the $E_{1,2}^-$ bands and others assigned to trapped electrons, recombination luminescence was observed. For example, bleaching of the E_1^- and E_2^- centers was accompanied by broad glow peaks near 125 and 280°K, respectively. The emission processes were assigned to recombination between a "freed" electron and a trapped hole center (the H_1^+ center). The luminescent centers also showed a range of thermal stabilities and corresponding shifts in the emission peak wavelength (from 330 to >420 mμ in the temperature range covered); thus their emission was quenched thermally over a wide temperature range. Other centers were associated with four absorption bands, which were stable to higher temperatures. Two visible bands (peaked at 460 mμ and 620 mμ) were assigned to trapped holes while two bands in the ultraviolet (peaked near 305 and 235 mμ) were assigned to trapped electrons. Thermal bleaching of the latter centers was accompanied by glow peaks in the 450 to 550°K range. (auth)

5953 COMPETITIVE TRAPPING IN SODIUM DISILICATE GLASSES DOPED WITH Eu^{3+}. Mackey, J. H.; Smith, H. L.; Nahum, J. (Mellon Inst., Pittsburgh). J. Phys. Chem. Solids, 27: 1773-82(Nov.-Dec. 1966).

Optical processes in x-irradiated sodium disilicate glasses with additions of Eu^{3+} up to 1% were studied. The added europium was assumed to have an electron trapping cross section proportional to its concentration and to compete with native defects for electrons generated by the x rays; thus, the "free" electron concentration is suppressed by Eu^{3+}. By considering these effects for small x ray doses, it was possible to demonstrate that an absorption band growing at 343 mμ was indicative of the photoreduction of europium; a composite absorption band ($E_{1,2}^-$ band) peaked in the red or orange and another band peaked at 305 mμ (E_3^- band) were the absorptions of trapped electrons; and that two other bands peaked at 460 mμ (H_2^+) and 620 mμ (H_3^+) were absorption bands of trapped holes. The results show that luminescent processes involving a characteristic violet emission of silicate glasses should be interpreted as resulting from the recombination of a "free electron" at the site of a trapped hole (H_1^+ center). These results give additional support to the evidence previously reported for the nature of optical centers observed in alkali silicate glasses. (auth)

5954 GAMMA-IRRADIATION PRODUCED COLOUR CENTRES IN ENGLISH FLUORITE. Burr, K. F.; Penhale, L. G. (Royal Military Coll. of Science, Shrivenham, Eng.). J. Phys. Chem. Solids, 27: 1949-51(Nov.-Dec. 1966).

Examples of colorless English fluorite were assessed as possible alternative sources of supply of very pure CaF_2. Optical absorption spectra measurements were made on samples of colorless fluorite from Cumberland, Derbyshire, Cornwall, Westmorland, and Durham, and one pale blue specimen from the Cumberland. None of the crystals showed the strong uv absorption at 210 mμ associated with oxygen. After 100 krad of ^{60}Co γ irradiation at a dose rate of 2.5 mrad/hr one group of crystals had a 4 band spectrum with the main absorption bands at 400 and 580 mμ giving a light blue color. A second group of crystals showed peaks at 385 and 600 mμ and gave a deeper blue color. Further irradiation produced the growth of another peak in only the second group of crystals at around 500 mμ. After γ irradiation fluorescence was observed only in the second group of crystals. Immediately after γ irradiation all of the natural samples luminesced for several minutes. A laboratory prepared oxygen-contaminated crystal used as a control did not show this effect. Extensive analysis failed to show impurity differences that might account for the differences in absorption spectra and readiness to color under irradiation. Yttrium did not appear to play a dominant part. (D.H.M.)

5955 IONIZATION CURRENTS EXCITED BY β RADIATION IN SATURATED HYDROCARBONS. Chybicki, Mieczyslaw; Gzowski, Olgierd (Politechnika Gdanska Katedra II Fizyki, Danzig). Z. Phys. Chem. (Leipzig), 233: 117-22(1966). (In German).

Initial measurements were made of ionization currents excited in liquid hexane and heptane by β particles from tritium in relation to the electric field strength, the temperature, and the activity of the radioactive source. By investigation of the influence of simultaneous ionization by β and x radiation it was established that the ionization current is linearly dependent on the radiation energy absorbed by the liquid and that this current increases with temperature. (tr-auth)

5956 INVESTIGATION OF RADIATION CHEMICAL PROCESSES IN DIPHENYLMETHANE AND MONOISOPROPYLDIPHENYL. Kosa Somogyi, Istvan; Eroene, Gecs Maria (Central Inst. of Physical Research, Budapest). Magyar Kem. Foly., 72: 456-61(Oct. 1966). (In Hungarian).

Spectrophotometric measurements were made to determine the G(–S) values in diphenylmethane and monoisopropylbiphenyl irradiated by a ^{60}Co γ source at room temperature and at –196°C using $FeCl_3$ and p-nitrosodimethylaniline as solutes (S). The initial values of $G(-S)_0$ either in liquid or in the solid phase were found to be equal to the radical yields G(R) up to solute concentrations of about 10^{-3} M. The increase in G(–S) observed in solutions of higher concentrations can be explained by energy transfer. Radical yields as evaluated from ESR measurements reflect rather the equilibrium due to the onset of steady state processes, thus the values of $G(R)_{ESR}$ are presumably lower than the true radical yield. The mechanism of polymerization is discussed in the light of these experimental results. (auth)

5957 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. XVI. COPOLYMERIZATION IN EUTECTIC MIXTURES OF MONOMER PAIRS NON POLYMERIZABLE IN THE SOLID STATE. (COPOLYMERIZATION OF MALEIC ANHYDRIDE AND MONOPROPYL ENDO-METHYLENE-TETRAHYDROPHTHALATE). Hardy, Gyula; Fedorova, Natalia; Nyitrai, Karoly (Mueanyagipari Kutato Intezet, Budapest). Magyar Kem. Foly., 72: 461-3(Oct. 1966). (In Hungarian).

The kinetics of the solid state copolymerization of maleic anhydride and monopropylendo-methylene-tetrahydrophthalate was investigated in eutectics mixture and in other compositions. It was found that monomers which do not polymerize in the solid state can be copolymerized in monomer pairs, owing to the increased mobility of the monomeric molecules over the adjacent crystal surfaces. Copolymerization takes place in the surface layer only. The composition of the obtained copolymers also supports this fact. (auth)

5958 GAMMA RADIOLYSIS OF ACID SOLUTIONS OF TELLURIUM. Haissinsky, M.; Lunde, G.; Patigny, P. (Laboratoire Curie, Paris). J. Chim. Phys., 63: 1093-4(July-Aug. 1966). (In French).

The gamma radiolysis of tellurium compounds in 0.8N H_2SO_4 solutions was studied. The radiolytic products in the presence and absence of oxygen were determined. The reduction of Te^{6+}, oxidation of Te^{4+}, and formation of H_2O_2 were determined as a function of the dose absorbed. The results showed that the reaction scheme proposed for the oxidation of Te^{4+} in alkaline solution is not completely valid for acid solutions, and a separate reaction scheme is proposed. (J.S.R.)

5959 METHOD FOR MEASURING THE MEAN LIFETIME OF THE SUPERHEATED STATE OF A LIQUID. Sinitsyn, E. N.; Skripov, V. P. (Ural Polytechnic Inst., Sverdlovsk, USSR). Prib. Tekh. Eksp., No. 4, 178-80(July-Aug. 1966). (In Russian).

A simulated bubble chamber was used for measuring the state of a superheated liquid at various pressures under static conditions. The experiments were carried out with n-pentane and n-hexane under γ radiation and in natural conditions. An area of almost constant radiation response of superheated liquid was found near the boundary of spontaneous bubbling. (tr-auth)

5960 REGULARITIES IN THE PRODUCTION OF VOLATILE ^{97}Zr, ^{101}Mo, AND ^{102}Mo CHLORIDES BY REACTIONS OF FISSION FRAGMENTS WITH THE VAPORS OF CHLORIDE CONTAINING COMPOUNDS. Zvara, N.; Zvarova, T. S.; Krzhivanek, M.; Chuburkov, Yu. T. Radiokhimiya, 8: 77-84(1966). (In Russian).

The delay of the atoms of the ^{97}Zr, ^{101}Mo, and ^{102}Mo yield in chloride vapors of different elements leads to the formation of molecules of weakly adsorbed compounds of these elements, probably $ZrCl_4$ and $MoCl_5$. The delayed atoms of the fission not having surplus energy because of nuclear conversions are chlorinated under the effects of chloride vapor. In the presence of the vapors of some non-isotopic chloride carriers, molecules of $^{101}MoCl_5$, $^{102}MoCl_5$, and $^{97}ZrCl_4$ are transported by gas currents (N_2, Cl_2, CO_2, etc.). The effects of the nature of the carrier, temperature, and composition of the gas on the efficiency of such transportation were studied. Isotopes of rare earth elements, forming non-volatile chlorides, are not transported by the gas. The hypothesis was expressed that with the basic factors, explained by the observed regularities, reversible adsorption of the transported molecules of the microcomponents appears on the walls of the apparatus. (tr-auth)

5961 CONTRIBUTION TO THE STUDY OF CHEMICAL DOSIMETRY BY CHROMATOGRAPHY OF A WATER–BENZENE–PHENOL MIXTURE. Caire, Bernard; Ordinaire, Lionel (CEA,

Bagnols-sur-Ceze, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-78/17, 24p. (In French). (CONF-661005-11). DTIE.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna.

Phenol is produced by subjecting a benzene-saturated water sample to gamma radiation. The concentration of the phenol is proportional to the integrated flux. Chromatographic determination of the phenol in the gaseous phase makes it possible to work with very small quantities of liquid. It is thus possible to make pinpoint measurements, and this constitutes an additional advantage of the method, over and above the greater convenience afforded by chromatography in the gaseous phase. (auth)

5962 FERROUS SULFATE G-VALUES FOR X-RAYS GENERATED AT 20 kV AND BELOW. Redpath, A. T.; Law, J.; Greening, J. R.; Randle, K. J. (Univ. of Edinburgh). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-78/10, 10p. (CONF-661005-18). DTIE.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna.

The x-ray unit used to determine ferrous sulfate G-values for x-ray beams, generated at peak energies of 20 kV and below has a Machlett fine-focus Be window tube and a constant potential generator. The inherent filtration of the beam is 1 mm Be, 0.04 mm aluminized "Melinex" and 10 cm of air between the tube focus and the measuring systems. The energy flux in the beam passing through a defining aperture is measured calorimetrically by total absorption of the x rays in Au sheet. The calorimeter is semi-adiabatic in operation and also includes an unirradiated absorber. Measurements are taken of the temperature difference between the two absorbers. As the absorbers have approximately the same thermal characteristics, external temperature variations appear the same for each, and hence are effectively reduced. X rays enter through an 0.025-mm aluminized "Melinex" window. Thermal insulation of the absorbers from the window, and from each other, is obtained by aluminized "Melinex" radiation shields and polytetrafluoroethylene rods. Fine nylon thread is used to suspend the absorbers from the rods. The assembly is enclosed in a vacuum flask, which is evacuated to a pressure of 10^{-6} mmHg. Thermal damping is improved by placing this vacuum flask in a larger vacuum flask filled with granular vermiculite. Temperature changes are detected by thermistors, which constitute two arms of an ac Wheatstone bridge. The out-of-balance voltage is amplified and displayed on a recorder. An electrical heating coil is used for calibration. Background drift rates less than 10^{-5}°C/min are obtainable. $FeSO_4$ irradiations are performed in polythene vessels with 0.04-mm aluminized "Melinex" windows. The size of vessel which, when filled with $FeSO_4$, will totally absorb the incident radiation is obtained by direct experiment, with a calculated correction for back-scatter from the incident surface. The production of Fe^{+3} is measured by routine spectrophotometry. A very brief discussion of the results is presented. (auth)

5963 RADIATION DOSIMETRY BY MEASUREMENT OF THE CHANGE IN ROTATION OF OPTICALLY ACTIVE SUBSTANCES. Suschny, O.; Frittum, H.; Eisenlohr, H. (International Atomic Energy Agency, Vienna). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-78/54, 20p. (CONF-661005-20). DTIE.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna.

Experiments were made to investigate the possibility of using the change in rotatory power under irradiation of optically active substances to determine the absorbed dose. A number of optically active substances were tested for their suitability in dosimeters for the megarad range. Carbohydrates, in particular, were found to give promising results. Dosimetry based upon sucrose solution is discussed in some detail. The mechanism is somewhat complicated by the formation of acid, which in turn acts on sucrose causing catalytic hydrolysis to glucose and fructose. However, this effect is not very large at intermediate concentrations and can even be turned to advantage since it compensates for the decrease in the sucrose decomposition rate with time which is caused by the competition of irradiation products with sucrose. The dependence of the change in rotatory power on sucrose concentration, integral dose, dose rate, and time between irradiation and measurement was studied. Under suitable conditions, a nearly linear response of the change in rotatory power with the absorbed dose was achieved. (auth)

5964 NONLINEARITY OF THERMOLUMINESCENCE AS A FUNCTION OF DOSE FOR LiF(TLD-100). Cameron, J. R.; DeWerd, L.; Wagner, J.; Wilson, C.; Zimmerman, D. (Univ. of Wisconsin, Madison). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-78/21, 16p. (CONF-661005-12). DTIE.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna.

The thermoluminescence (TL) of LiF is not in general a linear function of radiation dose. For gamma rays the TL is supralinear with R up to ~10^5 R where saturation and/or radiation damage reduces the amount of TL. The TL was expressed as a function of R from 0 to >10^5 R by an equation derived from a model that attributes the supralinearity to the "creation of traps" and the saturation to the finite number of traps available. The degree of nonlinearity depends on the quality and type of radiation used. This variation was investigated as a function of quality of radiation, type of radiation, and the temperature during irradiation. The results are expressed in terms of the parameters of the model. The "created traps," which have TL similar to the initial traps, can be destroyed thermally above ~280°C. There seems to be a correlation between the number of "created traps" and the number of color centers in the 5.5 eV absorption band. This band was identified as a Z_3 band. The relation of this band to the TL process is not yet known although it is clearly not the trapping center. If it serves as a recombination center, then the "created trap" would be replaced with a "created recombination center" concept. (auth)

5965 METHOD FOR PRODUCING ELASTOMERS BY GRAFT-COPOLYMERIZATION. Amamiya, Ayao; Suzuki, Ikuo (to Nichibo Co., Ltd.). Japanese Patent 1965-26555. Nov. 17, 1965. Filed Sept. 26, 1962.

A method is proposed for producing graft-copolymers with improved or modified elastic and mechanical strength properties by grafting diolefin monomers, such as isoprene, onto organic polymers in the presence of trivalent titanium salts without damaging the original polymers. Organic polymers irradiated with ionizing radiation in the air or in oxygen at more than 5×10^4R are brought into contact with diolefin monomers, such as isoprene, in the presence of trivalent titanium salts of concentration over 1×10^{-5} mole/l. (NSA of Japan)

5966 METHOD FOR IRRADIATING LONG-FILAMENT MATERIALS WITH IONIZING RADIATION. Shinohara, Yasuo (to Toyo Rayon Co., Ltd.). Japanese Patent 1965-28157. Dec. 13, 1965. Filed June 15, 1963.

A simple and efficient method is proposed for uniformly irradiating long-filament materials (such as thread, cord, or wire) with ionizing radiation. The material is wound around a drum at constant thickness, and the drum is passed through the radiation field while it is rotated. It is desirable for the drum to be a cylindrical one, but a multi-angled one may also be used. The thickness of threads etc., wound around the drum should be such that the radiation just penetrates through it. The material to be irradiated can either be wound prior to the irradiation process or while the drum is rotated in the radiation field. (NSA of Japan)

5967 METHOD FOR PRODUCING CHLORINATED POLYMERIC SUBSTANCES BY IONIZING RADIATION. Okamura, Seizo; Hayashi, Koichiro (to Japanese Association for Radiation Research on Polymers). Japanese Patent 1965-25907. Nov. 11, 1965. Filed Oct. 1, 1958.

A new method for producing chlorinated polymeric substances at high yields in a wide range of chlorine contents includes irradiating the polymeric substances with ionizing radiation in the presence of chlorine, with or without use of organic liquids proper to the polymeric substances. (NSA of Japan)

5968 METHOD FOR PRODUCING FOAMED BODIES OF POLYMERS OF ETHYLENE HOMOLOGUES. Sagane, Norio; Iida, Masahiro (to Sekisui Chemical Co., Ltd.). Japanese Patent 1965-25072. Nov. 1, 1965. Filed Oct. 29, 1962.

A method is proposed for the production of highly foamed bodies, in which mixtures of the polymers of ethylene homologs irradiated with ionizing radiation and foaming agents evolving gases by thermal decomposition are melted by heating above 120°C and then kept under pressure below 200 mmHg to give the foamed bodies. (TSS)

5969 METHOD FOR PRODUCING HELIOTROPINE PERFUME BY RADIATION. Kinoshita, Shosaku. Japanese Patent 1965-22463. Oct. 5, 1965. Filed Nov. 27, 1962.

A method is proposed for the production of heliotropin perfume by irradiation of insafrol, an aromatic compound, in the presence of oxygen. The process is simple and can give a high yield of the good-quality perfume In the cosmetics industry, heliotropin is important as the basic ingredient for the heliotrope perfumes and also as a modifier of general use. (NSA of Japan)

5970 METHOD FOR PRODUCTION OF PERFLUORO-OLEFIN POLYMERS. Yonetani, Yutaka (to Daikin Kogyo Co., Ltd.). Japanese Patent 1965-23352. Oct. 14, 1965. Filed Feb. 21, 1963.

In the method proposed for producing perfluoro-olefin polymers,

perfluoro-olefins having at least three carbon atoms and at least one double bond were irradiated in the solid state at low temperature below the melting point with high-energy ionizing radiation. (NSA of Japan)

5971 METHOD FOR CROSSLINKING OLEFIN POLYMERS. Hirosaburo (to Toyo Rayon Co., Ltd.). Japanese Patent 1965-21261. Sept. 21, 1965. Filed Aug. 28, 1962.

A method is proposed to improve the thermal properties of olefin polymers by crosslinking with ionizing radiation. Olefin polymers to be crosslinked are irradiated with ionizing radiation (and, if necessary, heated after irradiation) while in contact with one or more of the crosslinking accelerators selected from the group consisting of tetrachloroethane, trichloroethane, dichloroethane, chloroethane, tetrachloroethylene, trichloroethylene, and 1,2-dichloroethylene. The irradiation is carried out with a radiation dose of 0.2 to 100 Mrad at −50 to 300°C in an arbitrary atmosphere. (NSA of Japan)

5972 METHOD FOR PRODUCING CROSSLINKED POLYOLEFINS. Osawa, Toshikatsu (to Showa Electric Wire and Cable Co., Ltd.). Japanese Patent 1965-22198. Oct. 1, 1965. Filed Mar. 11, 1963.

A method for production of crosslinked polyolefins consists of mixing polyolefins with one or more of the compounds selected from aromatic conjugated quinones and/or their derivatives as aging retarders and then irradiating the mixture with ionizing radiation. The amount of the aging retarder is 0.02 to 4 parts by weight to 100 parts of the polyolefins. The resulting crosslinked polyolefins have good durability and are suitable as insulating materials for electric devices operating in the temperature range from 135 to 150°C. (NSA of Japan)

Radiochemistry

Refer also to abstract 5822.

5973 (N-66-31989) OPTIMALE BEDINGUNGEN ZUR MESSUNG RADIOAKTIVER PRAPARATE BEI BERUCKSICHTIGUNG DES STATISTISCHEN FEHLERS. (Optimum Conditions for Measurement of Radioactive Preparations by Consideration of Statistical Errors). Kambourov, Christo (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf, Institut fuer Strahlenschutz). 1966. 28p. (In German). (SGAE-SS-4/1966). CFSTI $3.00 cy, $0.65 mn.

Statistical optimization procedures were employed to obtain the most accurate radioactive measuring conditions for nuclear sources. Differential equations were first used to find the absolute minimum for overall measuring intervals, and then to compare the measured null reference values with maximal effects. (STAR)

5974 CHEMICAL EFFECTS ASSOCIATED WITH THE DECAY OF ^{132}Te IN DIPHENYL TELLURIDE AND SOLUTIONS OF $TeCl_4$ IN BENZENE AND ALCOHOLS. Adloff, Madeleine; Adloff, Jean-Pierre (Centre de Recherches Nucleaires, Strasbourg). Bull. Soc. Chim. France, No. 10, 3304-10(Oct. 1966). (In French).

The chemical forms of ^{132}I formed by decay of ^{132}Te in diphenyl telluride and solutions of tellurium tetrachloride in benzene and methyl, ethyl, propyl, isopropyl, butyl, and isobutyl alcohols were determined. A model assigning the essential role to the reactions at the interior of a self-irradiation zone, which developed around the site of the decay under the effect of Auger and conversion electrons, was proposed. (tr-auth)

5975 MOLECULAR PLATING. V. THE INFLUENCE OF SOME EXPERIMENTAL FACTORS ON THE DEPOSITION YIELD. Getoff, N.; Bildstein, H.; Proksch, E. (Seibersdorf Reactor Center, Vienna). Nucl. Instrum. Methods, 46: 305-8(1967).

The effects of cathode diameter, electrode distance, initial current, and temperature on the deposition yield using the molecular plating method were studied. ^{90}Sr/^{90}Y was used as a model nuclide. The best conditions to obtain a uniform layer with 100% yield are reported. (auth)

5976 PREPARATION OF OXYGEN REDUCED IN MASSES 17 AND 18 AND THE EFFECT ON TOTAL NEUTRONS EMITTED FROM $^{238}PuO_2$ PREPARED WITH THIS MATERIAL. Rutherford, W. M.; Huffman, G. N.; Coffey, D. L. (Monsanto Research Corp., Miamisburg, Ohio). Trans. Amer. Nucl. Soc., 9: 599-600(Oct.–Nov. 1966).

5977 SZILARD–CHALMERS REACTION OF ANIONIC COBALT COMPLEX IONS ON ION-EXCHANGE RESINS. Matsuura, Tatsuo (Rikkyo Univ., Sajima, Japan); Hashimoto, Tetsuo. Bull. Chem. Soc. Jap., 39: 2647-52(Dec. 1966).

The recoiling behavior of $[Co(C_2O_4)_3]^{3-}$, $[Co(NO_2)_6]^{3-}$, and $[Co(CN)_6]^{3-}$ ions on an anion exchanger was studied both by the dynamic and the static methods under various conditions. As the stability of the complex decreased, the separable yield increased as a general trend, and the effectiveness of the dynamic method in obtaining higher yield than the static method was clearly demonstrated. On the other hand, specific activity increased with increasing stability of the complex, i.e., with decreasing G values. The increase of pH generally decreased the separable yield and increased the specific activity. The effects of mesh size of resin and preirradiation by gamma rays were also studied. Since the observed tendency that the separable yield decreased with increasing stability constant of the complex ion seems to be a general one, a theoretical interpretation for this relationship was attempted. (auth)

5978 A RADIOCHEMICAL EXPERIMENT IN GAS CHROMATOGRAPHY. Merrigan, J. A.; Nicholas, J. B.; Rack, E. P. (Univ. of Nebraska, Lincoln). J. Chem. Educ., 43: 543-5(Oct. 1966).

Directions for building a radiogaschromatograph from materials generally available in a radiochemistry lab are described, as well as an experiment using this chromatograph to illustrate the Szilard-Chalmers effects, energies associated with nuclear transformations, and characteristics of the chromatograph. Diagrams show the basic features of the radiogaschromatograph. Helium is used as a carrier gas. After being separated in the column, the fractions of an injected sample enter one side of the dual thermal conductivity cell where macroscopic amounts (0.01 ml injected solution) compared to carrier gas are detected by an ordinary galvanometer or strip chart recorder connected across the Wheatstone bridge circuit. The effluent then flows through heated capillary tubing to a heated counting cell where microscopic amounts ($\sim 10^{-15}$ g) of radioactive products are monitored by the γ radiation emitted. The experiment was designed to show the variety of products formed when a liquid sample of Br_2 plus CCl_4 or hexane is submitted to a thermal neutron flux (such as in a neutron generator or small reactor), allowing short half-life ^{80}Br (18 min) and ^{80m}Br (4.5 hr) to decay out (about 48 hr), and running a radiogaschromatogram of the sample. The radioactivity detector reacts to the microscopic amounts of products by virtue of the decay of ^{82}Br to ^{82}Kr with the emission of β and γ rays. Typical spectra of radioactive products in CCl_4 and n-hexane are shown. The activity peaks are identified by adding carriers, consisting of the compounds expected to be formed during the irradiation, and observing if the carriers emerge from the column concurrently with the radioactive products. Their emergence is monitored by a thermal conductivity cell. Concurrence of detections provides a tentative identification of the radioactive product peaks. (BBB)

5979 FURTHER CHARACTERISTICS OF o-IODOBENZOIC-^{131}I ACID. Eysselt, Milos (Univ., Brno). Scripta Med. Fac. Med. Univ. Brun. Olomuc., 39: 21-3(1966).

The radiolytic decomposition and stability of ^{131}I-labeled o-iodobenzoic acid (OIB-^{131}I) under conditions used for preparing sterile solutions for intravenous use are reported. Radiolytic decomposition of OIB-^{131}I was followed by electrophoresis on paper in 0.1M acetate buffer and also by biological tests in rabbits over a 3-week period from the time of preparation. A fresh solution of OIB-^{131}I and the same solution after 1, 2, and 3 weeks were examined. In the freshly prepared solution of OIB-^{131}I, free ^{131}I in an amount of 0.1 to 0.13%, was found; in the week-old preparation 1 to 1.2%, 2 weeks 2.3 to 2.5%, and 3 weeks 5.5 to 5.9%. Results of the 2 methods agreed. These results show that it is preferable not to use OIB-^{131}I solutions older than one week, and that the preparation of this substance immediately before use is advisable to ensure that the patient is given a minimum amount of free ^{131}I, so that blocking of the thyroid by Lugol's solution is unnecessary. By observing free ^{131}I in solutions of OIB-^{131}I after 20-min sterilization in an autoclave, it was discovered that this method of preparing a sterile solution for parenteral administration is not suitable without control of the extent of decomposition. (BBB)

5980 STABILITY OF SODIUM o-IODOHIPPURATE (o-^{131}I). Kato, Sadatake; Kurata, Kunio; Sugisawa, Yoshihiko (Dainabot Radioisotope Labs., Ltd., Tokyo). Yakugaku Zasshi, 85: 935-8 (1965). (In Japanese).

Stability of sodium o-iodohippurate-^{131}I in various media and storage conditions was studied. Protection against self-radiation damage was found in benzyl alcohol, citric acid, and sodium o-iodohippurate itself, while addition of sodium chloride had no effect on its stability. This radioactive compound seemed to be more stable at low pH. Iodine was released by autoclaving. There was no significant effect of storage temperature, but there was a marked effect of direct sunlight on stability. Some preliminary experiments were performed to determine the reliability of a paper

chromatographic method for detecting radiochemical purity of this compound. Prevention of loss of radioactivity before measurement, exchange reactions during development, comparison of the accuracies of the scanning method, a counting method (with well-type scintillation counter), and an electrophoretic method were described. (BBB)

5981 PRODUCTION OF XeO_3 BY β DECAY OF ^{131}I IN HIO_3 AND I_2O_5 COMPOSITION. Kirin, I. S.; Murin, A. N.; Nefedov, V. D.; Gusev, Yu. K.; Selikhov, G. G. Radiokhimiya, 8: 104-9 (1966). (In Russian).

The possibility of the formation of the trioxide of ^{131m}Xe during the β decay of ^{131}I in the compounds I_2O_5 and HIO_3 was examined. It was found that the introduction of XeO_3 as a carrier leads to an increase in the yield of the bound xenon. (tr-auth)

5982 THE TRITIUM BETA-RAY INDUCED REACTIONS IN DEUTERIUM OXIDE VAPOR AND HYDROGEN OR CARBON MONOXIDE AND THE EXCHANGE OF H-ATOMS WITH WATER MOLECULES. Bibler, Ned Eugene. Columbus, Ohio, Ohio State Univ., 1965. 160p.

Thesis.

Reactions occurring in $D_2O/TOD:H_2$ and $D_2O/TOD:CO$ systems were investigated at pressures ranging from 0.35 to 1.7 atm and as a function of temperature between 84 and 380°C. The products, characterized by mass spectrometry and gas chromatography, were HD and D_2 in the first system, and CO_2, D_2, CD_4, CD_3OD, and other low molecular weight organic compounds in the second. Evidence was also obtained concerning the reactions of T atoms with the additives. In the system containing H_2, the yields of HD and D_2 were essentially independent of temperature below 150°C. Above this temperature a chain mechanism begins, and G(HD) and $G(D_2)$ increase with apparent Arrhenius energies of 19.5 ± 1 and 21 ± 3 kcal/mole, respectively. A free radical mechanism involving a first-order diffusion-controlled termination reaction is proposed. The activation energy for G(HD) is assigned to a weighted sum of Arrhenius energies for both an exchange and an abstraction reaction between H-atoms and water molecules. From the lack of substantial curvature over a range of 100°C in the Arrhenius plots, it is apparent that the Arrhenius energies of the two reactions are nearly equal. The yield of D_2 in the chain mechanism is attributed to the reaction of D-atoms with HD molecules. Below 150°C the value obtained for $G(D_2)$ is 0.7 ± 0.1 molecule/100 eV. A comparison is made with the previous results obtained for the $H_2O/TOH:D_2$ system and it is concluded that below 150°C the radical pair yield in either D_2O or H_2O vapor is 12.6 ± 0.6 radical pairs/100 eV. Above 150°C a kinetic isotope effect of approximately 1.3 for k_H/k_D is found and the value of E_D-E_H of 1 kcal is determined. In the mixture containing CO, the values of $G(CO_2)$ and $G(D_2)$ were found to be equal. Their temperature dependence and magnitude indicated a chain mechanism. On the basis of the proposed free radical mechanism, the observed activation energy of 22 ± 3 kcal/mole is assigned to the reaction of D-atoms with D_2O to produce D_2. A separation factor between product D or T atoms appearing as free hydrogen was found to be 1.7 in both systems, which indicates the presence of an intramolecular isotope effect. The source of this effect is attributed to the dissociation of electronically excited molecules and proton transfer reactions. (Dissertation Abstr.)

5983 PREPARATION OF RADIOACTIVE SOURCES BY ELECTRODEPOSITION FOR ALPHA SPECTROMETRY. Acena, M. L. (Junta de Energia Nuclear, Madrid). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/40, 10p. (In Spanish). (CONF-661012-5). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

A process is described for preparing radioactive sources with low self-absorption by electrodeposition on a cathode of polished refractory steel. Operations are carried out with a total volume of about 5 ml of a 2.5M NH_4Cl electrolyte at a pH ~1 in a specially designed Al and plexiglass cell. A piece of teflon limits the deposition surface on the cathode. A Pt anode 1.7 cm in diameter is rotated by means of a synchronous motor at 600 rpm at a distance of 0.5 cm from the cathode. Appreciable electrodeposition yields were obtained in operations carried out with a cathode current density of 870 mA-cm^2 produced by an electrode voltage of 8 to 10 V and a maximum time of 30 minutes. This technique was used to prepare sources of enriched uranium containing 0.78% ^{234}U, 90.2% ^{235}U, 0.33% ^{236}U, and 8.69% ^{238}U, as well as sources of $^{239}Pu + ^{240}Pu$, $^{232}Th + ^{230}Th$, and ^{241}Am. The activities of the sources varied between 10 and 50,000 dpm and adhesion and homogeneity characteristics were excellent. Appreciable deposits of these same elements were also obtained by using solutions containing all the elements. This provides a good method for carrying out quantitative determinations of mixtures of these α emitters. With the help of these sources it was possible to obtain different α spectra by using silicon barrier detectors together with a pulse height analyzer. No loss in resolution as a result of self-absorption was detected in the spectra peaks and no low energy tail was found. (auth)

5984 PREPARATION AND CALIBRATION OF ALPHA-ACTIVE SOURCES OF THE ACTINIDE ELEMENTS. Glover, K. M. (Atomic Energy Research Establishment, Harwell, Eng.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/39, 16p. (CONF-661012-10). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

Methods used for the preparation of standard α sources in the range from 0.001 μ Ci to 1 m Ci are vacuum sublimation and electrospraying. Vacuum sublimation is preferred since uniform films giving the required resolution of <20 keV full width half maximum peak height (FWHM) are consistently obtained. However, the efficiency of this method for a 1 to 2-mm diameter source is only about 1% and electrospraying with an efficiency of 75% is preferred for those actinide nuclides of which only milligram or lesser quantities are available. The instruments used to calibrate α sources include a low-geometry proportional counter, used to measure the absolute disintegration rates of sources in the activity range from 0.1 μCi to 1 mCi with an accuracy of ±0.2%, whereas for sources of less than 0.1 μCi the accuracy obtainable is of the order of 1%. The individual α-emitting nuclides present in a mixed α source can be assayed quantitatively to an accuracy of 1% with a suitable detector and ancillary electronic equipment, assuming that the peaks are well resolved. For high-resolution α spectroscopy measurements, a gridded ion chamber with a resolution of 25 keV FWHM is used for large sources and activity levels of less than 0.01 μCi, but for sources of activity >0.1 μCi, a Si–Au surface barrier detector chamber capable of giving a resolution of at least 15 keV FWHM is used. To overcome the problem of gaseous daughter products a low-geometry counter with a solid-state detector is being developed. (auth)

5985 ACCURACY OF CALIBRATED RADIOACTIVE SOLUTIONS. Le Gallic, Y.; Thenard, M. (CEN de Saclay, Gif-sur-Yvette, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/52, 32p. (In French). (CONF-661012-17). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

The chemical compositions of radionuclides in solution were studied and their constancy over periods of several years checked using many different measuring techniques ($4\pi\beta$, $4\pi\beta$-γ, liquid scintillation, α- β- γ ionization chambers, defined solid angle α differential gas counting, etc.). Using semi-conductor spectrometers (Si–Li and Ge–Li) it was shown that the inaccuracy of radioactive standards is largely due to radiochemical and radioisotopic impurities both in the solutions and in the carriers. It is also shown that fundamental radioactive parameters such as half-life are not properly known, and the effect of this on accuracy is also pointed out. All these factors show that in general the contribution of measurement to the final error is much less than the contribution of the other factors which intervene throughout the entire process of preparing the standard. (auth)

Separation Processes

Refer also to abstracts 5744, 5757, 5834, 5865, 6093, 6763, 6864, and 7890.

5986 (BNWL-113-22) PLUTONIUM ABSTRACTS. Volume 6, Number 10. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 30, 1966. Contract AT(45-1)-1830. 43p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Ninety-nine references on plutonium are given to journals and reports published from Nov. 1965 through 1966. The various fields covered include chemistry, metallurgy, health and safety, physics, and reactor technology. (P.C.H.)

5987 (BNWL-204(Pt.2)) AQUEOUS DECLADDING AND DISSOLUTION OF PLUTONIUM RECYCLE TEST REACTOR FUELS. PART 2. PuO_2–UO_2 FUELS. Schulz, W. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1966. Contract AT(45-1)-1830. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Laboratory studies of the decladding and dissolution of PRTR UO_2 – 0.5 to 1.0 wt % PuO_2 fuels were performed with both irradiated and unirradiated material. These studies culminated in two satisfactory procedures for dissolution of the PuO_2–UO_2 core. One procedure uses a boiling HNO_3–NH_4F solution as the solvent and the other uses the same solution at 60 to 80°C. Irradiation of the fuels to 1000 to 2000 MWd/ton U apparently resulted in significant in-reactor conversion of oxide mixtures to

solid solutions as found by the much greater (60 to 75%) solubility of the Pu in HNO_3. (P.C.H.)

5988 (CEA-R-2877) METHODE DE SEPARATION DES TERRES RARES PAR ELECTROPHORESE A HAUTE TENSION SUR PAPIER-SUPPORT. (Separation Method for Rare Earths Using High-Voltage Electrophoresis on Paper Strip). Clarence, Jeanine (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug. 1966. 92p. (In French). Dep. mn.

The mobilities and the separations of the rare earths in lactic, and α-hydroxyisobutyric acid solutions were investigated on cellulose acetate strip. Better results were obtained with α-hydroxyisobutyric acid. The equipment included an electrophoresis set running at 3,000 V and 20 mA. Two cooling plates were used as heat exchanger, and a pneumatic pressure device to ensure a uniform pressure on the paper strip laid flat. The method is rapid and allows a fine fractionation of rare earth elements within less than an hour. A complete separation of a Ce–Pr–Nd–Pm–Eu mixture, and a Y–Tb mixture was obtained. (auth)

5989 (CONF-651081–) 4TH WORKING CONFERENCE ON STABLE ISOTOPES: SEPARATION, USE, AND ANALYSIS OF STABLE ISOTOPES AS WELL AS CHARACTERISTIC ISOTOPE SYSTEMS, LEIPZIG, GERMANY, OCTOBER 24–29, 1965. (Deutsche Akademie der Wissenschaften zu Berlin (East Germany)). 156p. (In German and Russian). Dep. mn.

Summaries of papers presented at the conference are grouped under the following topics: separation of stable isotopes; analysis of stable isotopes; research on characteristics of isotope systems; use of isotope systems; stable isotopes in biology, medicine, and agriculture; and isotope geology. (M.C.G.)

5990 (DP-1016) CURIUM PROCESS DEVELOPMENT, III-2. IDENTIFICATION OF SOLVENT DEGRADATION PRODUCTS. West, David L.; Narvaez, Richard (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov. 1966. Contract AT(07-2)-1. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The principal products of solvent degradation during two of the solvent extraction steps of the curium process were identified as primary and secondary amines (from the tertiary amine extractant) and aromatic alcohols and ketones (from the diethylbenzene diluent). In batch tests, the principal causes of solvent degradation were radiolysis in the extraction banks of the nitrate-to-chloride conversion step and chemical oxidation during solvent washing in the lanthanide removal step. Hydrazine was found to inhibit solvent degradation in the conversion step. (auth)

5991 (IDO-14680) CHEMICAL AND PROCESS DEVELOPMENT BRANCH ANNUAL REPORT, FISCAL YEAR 1966. Bower, J. R. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Oct. 1966. Contract AT(10-1)-205. 114p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Aluminum- and zirconium-based fuels were processed. Uranium recovery from the aluminum fuel process was satisfactory, even though unusual surfactancy of the feed solutions caused some processing difficulties. The versatility of the semi-continuous, boron-poisoned, hydrofluoric acid process for zirconium-based fuels was amply demonstrated by the successful processing of standard PWR-type fuels, zirconium fuels containing stainless steel pins, and aluminum cans filled with zirconium scrap. Approximately 1.1 kg of ^{237}Np were recovered during routine processing of aluminum and zirconium fuels. Boron carbide in ATR fuel was shown to promote emulsion formation under extraction column conditions; boiling with gelatin appeared to alleviate the problem. Hydrogen formation during charging of zirconium fuel to a dissolver was found to be significant if the boric acid (6.3 g/l) solution in the dissolver (at 20°C) contained 0.003 M or greater hydrofluoric acid residue. The recovery of uranium from zirconium-fuel dissolver heels was hampered by the presence of stainless steel in the residue. Sulfuric acid was effective in releasing the uranium, which was not dissolved by the usual chromic acid reagent while stainless steel was present. Corrosion effects on the Monel dissolver are reported for the cleanout reagents. Recovery of uranium from EBR-II scrap resulting from the pyrometallurgical process was shown to be practical by use of a nitric acid dissolution process. Recovery of uranium from a melted LOFT reactor core (uranium dioxide partly fused with Zircaloy-4) appears to be possible by use of alternate nitric acid and hydrofluoric acid dissolution steps in a Carpenter-20 vessel. Uranium dioxide–zirconium dioxide fuel clad in Zircaloy-4 was completely dissolved in a three-step aqueous process using varying concentrations of hydrofluoric acid for decladding and core dissolution and chromic acid for uranium recovery. Calcium oxide in the core slowed the dissolution process, but the rate of corrosion on the Monel dissolver may offer the greatest drawback to the process. A modified burn-leach process for graphite fuels demonstrated the possibility, on a pilot-plant scale, of separating the metal oxide combustion products from the fluidized-bed alumina particles by carrying the ash overhead in the off-gas stream. Uranium was leached essentially quantitatively from the elutriated product by nitric acid treatment. Alternate processes for graphite fuels, a grind-leach process and a nitric acid-sulfuric acid oxidation process, were shown to be chemically feasible and to give essentially quantitative recovery of uranium. In miscellaneous equipment performance studies, final refinement of the air pulser mathematical model was accomplished. A mathematical and experimental study of the effects of pulsation on heat transfer in a liquid-fluidized bed was completed. The ICPP Waste Calcining Facility (WCF) started operation on its second processing campaign during the last quarter of FY 1966, and at the end of the period was operating smoothly and had calcined about 142,000 gallons of waste on this campaign. The net feed rate to the calciner averaged 67.5 gallons per hour for a 90-day period; this is 12% above design and was attained in spite of some feed system plugging problems. Pilot plant calcination of zirconium-, ammonium-, and sodium-containing wastes disclosed a number of important variables involved in handling the varied wastes processed in the WCF. A pilot plant run with normal aluminum nitrate-type waste, made under the same conditions used in the first WCF run, gave a basis for comparison between the two calciner systems and, hence, a basis for predicting the operating performance of the WCF when processing the other types of waste. All appear to be processable either in proper combination or, under certain circumstances, with the use of additives. A theory of particle growth and size distribution in fluidized-bed processes is presented in terms of a mathematical model, and computer solutions compare favorably with observed experimental results. Other calcination development studies reported include: a determination of the ruthenium dioxide–oxygen–ruthenium tetroxide equilibrium and its relation to ruthenium in the calciner off-gas; a finding that mercury contained in the calcine will migrate out of areas hotter than 400°C and will collect in a maximum concentration in the 125°C zone; and a study of the leachability of fission products from WCF calcine. Heat transfer studies affecting the calcination process and the storage of the calcined product include findings that: the rate of heat transfer to a fluidized bed can be increased by the use of finned tubes; shrouds to promote convection around calcine storage bins inside a vault are not necessary since the reflection of radiant heat back to the bin negates any improvement in heat transfer by convection; and a mathematical model formulated for predicting the temperature distribution around a heat source buried in soil was found to give reliable results when compared with an actual experimental study. LOFT assistance studies continued to be directed toward decontamination of possible reactor containment shell coatings. Several coatings were found to have adequate resistance to the anticipated exposure conditions, but decontamination behavior was disappointing for all coatings. Effective decontamination from iodine within the first few days after the simulated nuclear accident can only be obtained by removing a layer of the surface from the material being decontaminated. The Contamination–Decontamination Experiment (CDE), an experimental unit for releasing fission products from melted, irradiated fuel specimens into a confined, controlled-atmosphere test chamber, was constructed and operated successfully. The CDE is being used to study contamination and decontamination of protective coatings, to test various LOFT sampling devices, and to provide samples for development of analytical methods needed to assess the LOFT experiments from a radiochemical standpoint. A continuous sampler-monitor for the LOFT containment building atmosphere and possible absorptive reagents for use in the device are undergoing development; progress is reported but a final design is not yet established. Fission gas retention properties of several fuel plates were studied. Fuel particles of either U_3O_8 or UAl_3 in aluminum matrices released fission gases on reaching a temperature of 575 to 600°C; the gas release was more rapid from UAl_3 particles than from U_3O_8. (auth)

5992 (JINR-P-2877) BYSTRYI METOD POLUCHENIYA KONTSENTRIROVANNYKH RASTVOROV FRANTSIYA EKSTRAKTSIONNOI KHROMATOGRAFIEI. (Fast Method of Solving Concentrated Fr Solutions by Means of Extraction Chromotography). Mal'tseva, N. S.; Shalaevskii, M. R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 16p. (In Russian). Dep. mn.

A fast effective method is suggested for extracting Fr from Au foil bombarded with neon-22 ions by means of extraction chromatography. Francium is extracted by sodium tetraphenylboron solution in nitrobenzene. Francium is concentrated as drops, which permits the preparation of qualitative sources for α radiation measurement. The method can also be used for Cs radioisotope concentration. (auth)

5993 (JUL-402-PC) ISOTOPIE-EFFEKTE BEI IONEN-AUSTAUSCHERTRENNUNGEN VON SELTENEN ERDEN. (Isotope Effects in the Ion Exchange Separation of Rare Earths). Ihle, H.; Michael, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Physikalische Chemie). Aug. 1966. 18p. (In German). Dep. mn.

The isotope effects that occur during the separation of rare earths on ion-exchange columns were measured. The investigation was carried out by partition of Sm^{3+} between Dowex 50W cation-exchange resin, and aqueous solutions of α-hydroxyisobutyrate and tartronate as complexing agents. The separation factor for two samarium isotopes, differing by one mass unit, was found to be $K = 1 + 3 \times 10^{-5}$. In agreement with the theory, the lighter isotope was enriched on the resin. As expected, the measured effect was smaller than the maximum value calculated from theoretical considerations under idealized conditions. (auth)

5994 (K-1518) IMPORTANT ROLE OF ELEMENTAL FLUORINE IN URANIUM PROCESSING OPERATIONS. Smiley, S. H.; Brater, D. C.; Littlefield, C. C.; Pashley, J. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Dec. 28, 1966. Contract W-7405-eng-26. 38p. (CONF-409-4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Chemical Society 138th Meeting, New York, Sept. 1960.

The results of experimental fluorination studies carried out at gaseous diffusion plants are reviewed and evaluated. Information is presented on the development of the vertical flame fluorinator presently being used by the AEC for uranium hexafluoride production from uranium tetrafluoride. Experimental data on which production reactor design was based and operating conditions set are included. Also discussed are the various reactor configurations examined en route to the final design. Experimental findings from both the vibrating-tray and fluid-bed studies are summarized and discussed briefly. (P.C.H.)

5995 (MCW-1511) FLUID-BED DENITRATION OF THORIUM NITRATE. Nelson, E. N. (Mallinckrodt Chemical Works, Weldon Spring, Mo. Uranium Div.). Jan. 19, 1966. Contract W-14-108-eng-8. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Weldon Spring pilot-plant fluid-bed denitrator was used to denitrate thorium nitrate. Since the denitration was carried out in a closed system, good control of dust and fumes generated during the process was possible. The product had a uniform, small crystallite size (50-70 Å), would almost completely disperse in water, and in general appeared to be an excellent feed for the sol-gel process. Dense, high-fired thoria was used as the bed material, and a production rate of about 100 lbs Th/hr was obtained at a minimum bed temperature of 700°F. Feed solution of thorium nitrate as high in concentration as 8.0 lbs Th/gal could be fed to the bed without difficulty. (auth)

5996 (ORNL-4001) STATUS AND PROGRESS REPORT FOR THORIUM FUEL CYCLE DEVELOPMENT FOR PERIOD ENDING DECEMBER 31, 1965. Wymer, R. G.; Douglas, D. A. Jr. (comps.) (Oak Ridge National Lab., Tenn.). Oct. 1966. Contract W-7405-eng-26. 129p. Dep. mn. CFSTI $4.00 cy, $1.00 mn.

Developments are reported for studies on: process demonstration; thorium-uranium recycle facility; coated-particle development laboratory; sol-gel process for Th and U; fueled graphite; bulk oxide process; irradiation of oxide fuels; and basic properties and structure of ThO_2 and ThO_2-UO_2 sols. (P.C.H.)

5997 (RFP-776) DISSOLUTION OF PLUTONIUM-BEARING RESIDUES IN A NITRIC ACID-CALCIUM FLUORIDE SOLVENT SYSTEM. Molen, G. F.; Wing, R. O. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Nov. 22, 1966. Contract AT(29-1)-1106. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The dissolution of plutonium-bearing residues in a nitric acid-calcium fluoride solvent system is described. The length of the reflux period, the drying temperature of heels, the solid to liquid ratio, the addition of fluoride during dissolution, and the effectiveness of a multiple contact system are evaluated in terms of the effects they have on the dissolution of these residues. (auth)

5998 (RFP-782) NEUTRON POISONED ION EXCHANGE EQUIPMENT. Irwin, D. S. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Nov. 15, 1966. Contract AT(29-1)-1106. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A neutron-poisoned ion exchange column was built for use in the purification of plutonium nitrate solutions. The column was poisoned by stainless steel grids containing ^{10}B. The column performed satisfactorily but was found to be uneconomical. An improved design utilizing boron carbide tubes instead of grids was developed. This design would overcome most of the difficulties of the grid column but would offer little economic advantage over non-poisoned ion exchange equipment. (auth)

5999 (RL-SEP-674) EQUIPMENT FOR THE DIRECT CALCINATION OF PLUTONIUM NITRATE. Felt, R. E. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Dec. 1965. Contract AT(34-1)-1350. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Continuous calcination equipment for the direct conversion of a plutonium nitrate solution to plutonium oxide has been designed and demonstrated. The limitations of an agitated bed calciner and a vertical calciner were shown in areas of operation reliability and oxide product characteristics. The adequacy of a horizontal screw calciner was verified during 200 hr of operation in which 67.5 kg of plutonium oxide were produced. Optimum operating conditions established were: feed rate, 0 to 500 g Pu/hr; temperature, 400 to 450°C; screw speed, 10 to 20 rpm; and calcination additive, 0.25 moles/mole Pu. The horizontal screw calciner was constructed of titanium and showed minimal corrosion. A single ceramic filter for filtering the off-gas of the screw calciner was found to be adequate and reliable. The oxide produced by direct calcination required an additive to improve fluorination reactivity. The additive-containing plutonium oxide was fluorinated and reduced to metal with greater than 95% metal yield. The production capability of the Direct Calcination Process has thus been demonstrated. (auth)

6000 (RT-CHI-(66)17) DISSOLUZIONE NITRICA DI ALLUMINIO E DI ELEMENTI DI COMBUSTIBILE MTR FREDDI IN CONDIZIONI ACIDE ED ACIDO DEFICIENTI. PARTE II. PROVE IN UN DISSOLUTORE SEMICONTINUO TIPO EUREX (FLOODED DISSOLVER) IN SCALA DI LABORATORIO. (Aluminum and Unirradiated MTR Fuel Elements Dissolution in Acid and Acid-Deficient Final Conditions. Part II. Experiments in a Laboratory Flooded Semicontinuous Dissolver). Beone, G.; Mazzoleni, G. P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 41p. (In Italian). Dep. mn.

Extensive studies of the mercury-catalyzed nitric acid dissolution of aluminum and unirradiated MTR fuel elements were carried out in a tall-pipe, flooded, semicontinuous dissolver for acid and acid-deficient final conditions. The dissolving rate of the metal increased significantly with increasing catalyst concentration and it was found to be directly proportional to the 0.42 power of the concentration except for a short range where the dissolving rate was constant. The dissolution time decreased strongly with increasing catalyst concentration and, at the same time, with changing of product final conditions from acid to acid-deficient. The dissolver off-gas consists of nitric oxide, nitrous oxide, and hydrogen. The amount of hydrogen present increased to a limit of about twenty percent, when the acid-deficient final conditions were ~4 M. Aluminum oxidation in acid-deficient conditions reduced Hg^{2+}, U^{6+} (and several impurities present) to mercury metal, mercurous ions, U^{4+}, etc. (auth)

6001 (AEC-tr-6836) UNDERGROUND LEACHING: A PROCESS FOR ECONOMICAL URANIUM EXTRACTION FROM LOW-GRADE ORES. Zefirov, A. Translated from a Russian Report No. 014. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fs, $0.80 mf.

The underground leaching of uranium ores in the USSR was studied in two types of deposits lying in laminar rocks and in sand-clay strata. Methods for uranium leaching of large pieces of ore and of strata in natural stratification were developed. Practical development of underground leaching of several uranium ores was demonstrated and procedures and operations of the industrial process completed. This process resulted in a significant decrease in uranium production cost in comparison with its cost by original industrial processing. The ore was removed by explosive drilling and was studied in underground blocks. Massive ore crushing was carried out; and to eliminate the loss of solution, the bottom of the block and its bore-pits on the ground-drift were water proofed. A reagent was conveyed over the ore stratum through a set of pressure bore-holes, transferring the uranium from minerals to solution and then the uranium-containing solutions were pumped out. Uranium extraction from produced solutions was accomplished by an extraction-absorption process, after which the solutions were used again for leaching. Mining based on this technique permitted the crushing and storing of removed ore in underground blocks with the drawing to the surface of not more than 10% of the total quantity of removed ore. (D.H.M.)

6002 (ORNL-tr-1478) ROLE OF THE DONOR ACCEPTOR INTERACTION IN SEPARATING ISOTOPES BY CHEMICAL EXCHANGE. Panchenkov, G. M.; Pechalin, L. I. Translated by S. J. Rimshaw and A. A. Palko (Oak Ridge National Lab., Tenn.), from Dokl. Akad. Nauk SSSR, 168: 382-5(1966). 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

Equations are given for the mechanism of the donor acceptor interaction in the separation of isotopes, such as sulfur, boron,

and hydrogen, by chemical exchange. It was found that the lower the value of I, or the easier the donor electron is given off, the greater the value of α, where I is ionization potential and α is the separation coefficient. It also follows that the more a structure of charge transfer prevails in a complex, the greater is the value of α. It was concluded that tentative values of I and P can be used as a guide in selecting systems for separating isotopes with the use of molecular compounds where P is the affinity of a donor for a proton. (P.C.H.)

6003 RECOVERY OF IODIDE-^{131}I FROM AQUEOUS SOLUTIONS OF pH 5. Oxby, C. B. (Univ. of Leeds, Eng.). Nature, 213: 68(Jan. 7, 1967).

An unexpected dependence on the amount of carrier iodide was found in the recovery of radioactive iodide by solvent extraction (benzene) of its aqueous solutions containing $NaNO_2$. The percentage recovery was inversely proportional to the amount of iodide in solution when the pH was between 4 and 7. The relationship was linear for the range of iodide concentrations examined (0.01 to 0.1 μg). This inverse relationship implies that an isotopic dilution effect occurs and that a constant amount of iodine is extracted. Mechanisms are discussed. Application to the possibility of developing a method for the determination of sub-microgram quantities of iodine is mentioned. Sensitivity and recovery were best at pH 5. (UK)

6004 SEPARATION OF ^{95,97}Zr AND ^{95,97}Nb FROM FISSION PRODUCT-MIXTURES AND IRRADIATED URANIUM BY AN EXTRACTION METHOD USING 8-QUINOLINOL. Motojima, Kenji; Hashitani, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 3: 326-32(Aug. 1966).

An 8-quinolinol-extraction method was applied to separate ^{95}Zr–^{95}Nb or ^{95}Nb from fission product mixtures and/or irradiated U. Radiochemically pure nuclides can be separated simply and rapidly from either origin. In the separation of ^{95}Zr–^{95}Nb, the extraction was made from a solution of pH 4.5 to 5.5, containing acetate as masking agent. ^{95}Nb was extracted from a solution of pH 4.8 to 5.2, containing fluoride as masking agent, in the presence of U. ^{95}Nb can be separated from ^{95}Zr and other fission products by extraction from a solution of pH 5.3 to 8, containing EDTA as masking agent. In these cases, after the first extraction, the chloroform solution should be washed with water to remove any remaining extraneous U or fission products. The addition of a small quantity of sulfite is required to prevent the extraction of ^{103}Ru. The method can be also used for the separation of the short-lived nuclides, ^{97}Zr–^{97}Nb or ^{97}Nb, from irradiated U. (NSA of Japan)

6005 DECONTAMINATION OF RADIOACTIVE RUTHENIUM BY CELLULOSE DERIVATIVE-BENTONITE FLOCCULATION. I. Ishiyama, Toshio; Matsumura, Takashi (Radiation Center of Osaka Prefecture, Japan). Radioisotopes (Tokyo), 15: 181-6 (July 1966). (In Japanese).

The utilization of cellulose ion exchanger as the agent for the bentonite flocculation of radioactive waste water was investigated, and the decontamination properties of cellulose ion exchanger-bentonite flocculation were studied with respect to the removal of radioactive nitrosylruthenium ions. The DEAE cellulose-bentonite flocculation was especially effective in removing the nitronitrosylruthenium complex, achieving a removal higher than 98%, where the formation of "organo-clay complex" through the combination of DEAE cellulose and bentonite particles was assumed to play an important role in increasing the removal of radioactive ruthenium, possibly because of the high adsorption capacity of "organo-clay complex" for the complexed anion $[RuNO(NO_2)_4OH]^{2-}$. (auth)

6006 EXTRACTION OF RADIOISOTOPE-PURE CARRIER-FREE ^{140}Ba FROM URANIUM FISSION PRODUCTS. Tot, B.; Gromov, B. V. Radiokhimiya, 8: 84-8(1966). (In Russian).

The effects of UO_2^{2+} ions on the formations of mixed crystals of the type $PbSO_4 \cdot {}^{140}BaSO_4$ and $PbSO_4 \cdot {}^{89}SrSO_4$ were investigated. It was established that the basic principle of the extraction of radioisotopically pure ^{140}Ba from uranium fission products, also containing strontium isotopes, is the presence of uranyl ions in large quantities, which, because of the formation of complex compounds of uranyl sulfate, are capable of displacing strontium ions from the crystal lattice and can separate ions of lead and barium. (tr-auth)

6007 COMPUTER SOLUTION OF SOLVENT EXTRACTION CASCADE CALCULATIONS FOR THE MONAZITE RARE EARTH NITRATES–NITRIC ACID–TRIBUTYL PHOSPHATE–WATER SYSTEM. Sebenik, Roger F.; Sharp, Brooks M.; Smutz, Morton (Ames Lab., Ames, Iowa). Separation Sci., 1: 375-86(1966). (IS–1096).

The trial and error calculations required to determine the composition and concentration of all streams in an internally fed countercurrent multicomponent solvent extraction cascade were programmed for an IBM-7074 computer. The method outlined for the monazite rare earth nitrates–nitric acid–TBP–water system was an adaptation of the Thiele and Geddes technique, in which systematic adjustments of end-stream concentrations were made repetitively for the component most mismatched at the feed stage. The equilibrium data were stored in the memory of the computer in table form, and equilibrium compositions were calculated by an empirical procedure. Although no attempt was made to optimize the matching procedure, rapidly converging solutions were observed. (auth)

6008 CHANGES TO PLUTONIUM EXTRACTION BEHAVIOR OF TBP AND ALKYLAMINES THROUGH IRRADIATION. Tsujino, Takeshi; Ishihara, Takehiko (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 3: 320-5(Aug. 1966).

Changes in plutonium extraction properties brought about through irradiation of 30 vol % TBP (tri-n-butyl phosphate)/kerosene and 5 vol % alkylamines/kerosene modified with lauryl alcohol were studied with respect to extraction, scrubbing, and stripping characteristics in nitrate media. The alkylamines examined were tri-n-octyl amine (TOA), N-cyclohexyl dilauryl amine (N-CHDLA) and Amberlite LA-2 (LA-2). These extractants were irradiated to the extent of 10^8 R by ^{60}Co γ rays prior to extraction. Marked changes with irradiation were observed in plutonium extraction performance with the TBP system tending to bring losses of plutonium, but very little change was found to occur with amine systems. Calculation of the single-stage decontamination factors of fission products from plutonium proved that separation deteriorated with irradiation in the TBP system but hardly changed in the amine systems. From these findings, tertiary amines, especially N-CHDLA, can be judged superior to TBP for the direct recovery of plutonium from irradiated fuels, a process that has to be carried out under high irradiation. The phase separation time after mixing in the extraction stage varied very little with irradiation, and no formation of emulsion occurred in the extraction of tracer plutonium with either irradiated TBP or amines. (NSA of Japan)

6009 GAS-CHROMATOGRAPHIC SEPARATION OF HYDROGEN ISOTOPES. Sakodynskii, K. I.; Cartoni, Dzh. R.; Pela, A. (Karpov Inst. of Physics and Chemistry, USSR, Inst. of General and Inorganic Chemistry, Rome). Zh. Fiz. Khim., 40: 2887-8 (Nov. 1966). (In Russian).

Gas-chromatographic separation of toluene from deuteriotoluene was achieved at 0 to 50°C. (R.V.J.)

6010 ISOTOPIC DISCRIMINATION OF SOME SOLUTES IN LIQUID AMMONIA. Viste, Arlen; Taube, Henry (Univ. of Chicago). Contract AT(04-3)-326. J. Phys. Chem., 70: 3763-7 (Dec. 15, 1966). (SU-326P6-17).

The nitrogen isotopic discrimination of some salts and metals, studied in liquid ammonia solution at −50°C, decreases in magnitude in the order Pb^{2+}, Ca^{2+}, Li^+, Ag^+, Na^+, Li, K^+, Na, K. The isotopic discrimination appears to provide qualitative information about the strength of the cation–solvent interaction in liquid ammonia. (auth)

6011 SEPARATION OF Tb, Gd, Eu IN MILLIGRAM AMOUNTS. PART 2. SEPARATION OF Tb, Gd, Eu BY ANION EXCHANGE. Ross, Richard; Roemer, Johannes (Zentralinstitut fuer Kernforschung, Dresden). Z. Phys. Chem. (Leipzig), 233: 25-30(1966). (In German).

It is shown that Gd and Eu can be separated from one another by anion exchange using nitric acid–methanol mixtures and can be used as β sources of high purity. The advantages over separation by cation exchange consist of greater separation factors; the columns can be loaded with 20 mg. In comparison with previous methods the elution volume was reduced to one quarter the volume previously needed. A complete separation of Tb and Gd was not obtained. (tr-auth)

6012 SEPARATION OF Tb, Gd, Eu IN MILLIGRAM AMOUNTS. PART I. SEPARATION OF Tb, Gd, Eu BY CATION EXCHANGE. Ross, Richard; Roemer, Johannes (Zentralinstitut fuer Kernforschung, Dresden). Z. Phys. Chem. (Leipzig), 233: 17-24(1966). (In German).

Lactic acid and α-hydroxyisobutyric acid were investigated for their applicability as elution media for the separation of Tb and Eu from milligram amounts of Gd on cation exchangers. It was established that α-hydroxyisobutyric acid at room temperature shows more favorable separation factors than lactic acid at 87°C and is therefore preferred. A larger separation factor for the Gd/Th separation than appeared in the literature was obtained, while that for Eu/Gd separation corresponded to literature values. (tr-auth)

6013 PRECIPITATION AND COPRECIPITATION IN THE PRESENCE OF EDTA. I. EFFECT OF THE CONDITIONS ON THE PRECIPITATION OF RADIOACTIVE BARIUM AND STRONTIUM BY THE SULFATE METHOD. Benes, J.; Vobecky, M. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences,

Rez). Collect. Czech. Chem. Commun., 31: 4398-4404(Nov. 1966).

The conditions for quantitative precipitation of radiochemically pure barium and strontium in the form of the sulfates in the presence of a chelating agent from a mixture of fission products were studied. The yields of precipitation of strontium and of coprecipitation of radioactive strontium on a barium carrier in the presence of ethylenediamine tetraacetic acid depend primarily on the pH of the medium and the ratio of the concentrations of the precipitated cation and of the sulfate ions. (auth)

6014 SOLID-LIQUID SEPARATION. A Review and a Bibliography. Poole, J. B.; Doyle, D. London, Her Majesty's Stationery Office, 1966. 1014p. Pound 5 5s 0d.

Reported theoretical and applied work in the field of solid–liquid separation are reported in abstract form and the major aspects of the subject are examined critically with a view to indicating specific areas where future research might most usefully be undertaken. Subjects covered are filtration; flocculation and coagulation; sedimentation; hydrocyclonic separation; centrifugation; electro-osmosis and related phenomena; plant control; water; sewage; effluents and trade wastes; coal; inorganic materials; and organic materials. (D.H.M.)

6015 EVAPORATOR FOR PROCESSING RADIOACTIVE SOLUTIONS. Auchapt, P.; Bouzou, G.; Sauteray, R. (to Commissariat a l'Energie Atomique). Canadian Patent 742,921. Sept. 20, 1966. Priority dates Sept. 19, 1963 and Jan. 30, 1964, France.

The evaporator is connected by thermo-siphons to two other vessels so that the quantity of solution subjected to heating at any instant is kept below criticality. As the density of the evaporating liquid increases some is drawn off by these thermo-siphons. Dilute solution flows in to maintain a constant level. The condenser is lined with neutron absorbing material. The device is intended mainly for Pu solutions and a high flow rate into the evaporator is claimed without danger of criticality. (F.S.A.)

EARTH SCIENCES

Geology

Refer also to abstracts 5763, 5989, 6318, and 6325.

6016 (RT-PROT-(66)-6) A CONTRIBUTION TO THE STUDY OF THE SORPTION PROPERTIES OF TUFFS. Boenzi, D.; Dlouhy, Z. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 14p. Dep. mn.

The Italian tuffs are compact volcanic rocks showing certain nonhomogeneities. The presence, besides the zeolitic material that forms the bulk of the cementing groundmass, of some accessory minerals seems to cause a dilution of the main active material (or materials) reducing their good sorption properties. Starting from this result an experimental research was carried out in order to try the separation possibility of the active fraction of an Italian tuff. The material was chosen because of its easy availability as well as of its good sorption properties. Four separation methods were examined: electromagnetic, separation in heavy liquids, hydrogravimetric, and mechanical method based on the different hardness of the constituting minerals. The results showed that the nature of the material does not allow a complete separation of the most active fraction from the less or inactive ones by means of the experimented methods, but it was possible to achieve a good economically available enrichment. (auth)

6017 SIGNIFICANCE OF SULFUR ISOTOPES IN THE EVALUATION OF QUESTION OF THE FORMATION OF STRATA. Anger, Gerhart; Borchert, H. (Institut fuer Mineralogie, Petrographie, Clausthal, Ger.). Neues Jahrb. Mineral. Abhandl., 98: 295-348(1962). (In German).

The differences between terrestrial and meteoritic sulfur isotope ratios are very small. The most important sulfuric isotope ratio is that of $^{32}S:^{34}S$; however, in late publications the ratio often is presented as $^{34}S:^{32}S$, or even δ values (‰): $\delta = (^{34}S/^{32}S \text{ (sample)} - {}^{34}S/^{32}S \text{ (standard)} \times 1000)/{}^{34}S/^{32}S$ (standard). Because of the differences in the standard values (USA: meteorite from Canyon Diablo, ratio = 22.21; USSR and Japan: meteorites 22.20; galena from Hosokura Mine, Japan, 22.25) it is often impossible or very difficult to recalculate the real ratios from δ values. The remarkable constancy of sulfur isotope ratios in meteorites is to be expected on account of a fractionation between iron and stone meteorites. In the sulfides of igneous rocks of most different types (dunites to granites), no definite fractionation of sulfur isotopes is found. All sulfur isotope ratios available from literature up to February 1960 are shown graphically. All sulfates (from seawater, salt domes, hydrothermal and other ore deposits) show a max at 21.80. A second max containing sulfur isotope ratios from sulfides of meteorites, and of various ore deposits, and from hydrogen sulfides of bleed water is at 22.20; a weak max ranges from 22.90 to 23.20 and corresponds to various sulfides of red bed deposits. The average values and the scattered values between min and max of sulfur isotope ratios are presented in a genetic scheme. (BBB)

6018 ISOTOPIC COMPOSITION OF LEAD FROM DIFFERENT TYPES OF ORE DEPOSITS OF EASTERN TRANSBAIKALIYA. Yesikov, A. D.; Tomson, I. N.; Konstantinov, R. M.; Polyakova, O. P. (Inst. of Geology of Ore Deposits, Petrography, Mineralogy, and Geochemistry, Moscow). Geochem. Int., 2: 608-16(1965).

Isotopic composition of lead ($^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, $^{208}Pb/^{204}Pb$) are presented for 40 galena specimens from Transbaikalian ore deposits of Middle and Upper Jurassic age (age determined by geologic relations and K/Ar). The general similarity of slope of the lines of fit on the 208/204 and 206/204 diagrams suggest a common source, or similar sources, for the several types of sulfide-rich deposits, which are associated with small intrusives, while the oxide-silicate deposits related to larger granite bodies show a somewhat different trend. Lead from the older Mesozoic deposits is enriched in ^{208}Pb and ^{207}Pb as compared with lead from the younger deposits, and the degree of enrichment in ^{207}Pb is considerably higher than might be expected for rocks older by only 25 million yr. Evidently there are other factors contributing to a change in the isotopic composition of lead, besides the age factor. It is possible that the relative enrichment in isotopes 207 and 208 is related to the localization of the older deposits in the ancient rocks. That is, not only the age but also the geological position of ore deposits may be reflected in the isotopic composition of lead occurring in them. (BBB)

6019 A REMARK ON THE CORRECTION FOR "ATMOSPHERIC" ARGON IN DATING ROCKS BY THE POTASSIUM–ARGON METHOD. Lambert, Gerard; Labeyrie, Jacques; Dumesnil, Patrice (Centre d'Etudes Nucleaires, Saclay, France). Earth Planet. Sci. Lett., 1: 443-5(Nov. 1966).

The only radiogenic isotope of rocks is argon-40, which originates in the decay of potassium-40. However, it appears that another isotope, argon-36, yielded by chlorine-36, may also be produced inside the rock. The appearance of argon-36, in variable and sometimes important quantities, may have an incidence on the estimation of the contamination of rocks by atmospheric argon, which must be taken into account. (auth)

6020 EFFECTS OF WEATHERING ON THE U–Pb AGES OF ZIRCON FROM THE MORTON GNEISS, MINNESOTA. Stern, T. W.; Goldich, S. S.; Newell, M. F. (Geological Survey, Washington, D. C.). Earth Planet. Sci. Lett., 1: 369-71(Nov. 1966).

Weathering has caused large losses of lead from zircon in the residual clay derived from the Morton Gneiss of southwestern Minnesota, drastically reducing the $^{206}Pb/^{238}U$ and the $^{207}Pb/^{235}U$ ages. The $^{207}Pb/^{206}Pb$ age probably has not been significantly affected. Loss of lead by leaching during weathering has not been adequately considered in explanation of discordant ages of zircon. (auth)

6021 ISOTOPIC CONSTITUTION OF SULPHUR IN SOME STRATIFORM LEAD–ZINC SULPHIDE ORES. Stanton, R. L. (Harvard Univ., Cambridge, Mass.); Rafter, T. Athol. Mineral. Deposita, 1: 16-29(May 1966).

Genetic relations of sulfide deposits were studied on the basis of $^{32}S/^{34}S$ values for five Australian stratiform lead–zinc sulfide ores. Each deposit was characterized by a narrow spread of values, mean $\delta^{34}S$ heavier than meteoritic, average crustal, and, where sampled stratigraphically, $\delta^{34}S$ related to stratigraphy rather than propinquity. When considered with other deposits of the same class from elsewhere, several general features appeared: mean $\delta^{34}S$ heavier than meteoritics; ranges for individual deposits narrow and rarely more than 8‰ with standard deviation ~ 1‰ to 2‰; individual values for the whole group spread between, but almost entirely restricted by, the values for meteoritic S and seawater SO_4; no age effect; no apparent relation between $\delta^{34}S$ and lead "type"; and where investigated, a stratigraphical affiliation. While no positive interpretation of these features was made, it is suggested that the sulfur concerned had been derived neither from migrant hydrothermal solutions nor from the H_2S of normal biological sulfate reduction in seawater. (BBB)

6022 INVERSE PROBE DIAGRAMS FOR NEUTRON–NEUTRON LOGGING OF VARIOUS SEDIMENTARY ROCKS. Belomar, O. D.; Bardovskii, V. Ya.; Arkhangel'skii, V. E. (Inst. of Mineral Resources, Simferopol, USSR). Izv. Akad. Nauk SSSR, Fiz. Zemli, No. 10, 105-6(1966). (In Russian).

Quantitative data are given for the inverse logging obtained by statistical evaluation of the neutron–neutron γ logging of 17 holes drilled in Perm rocks. The rocks consisted of rock salt, anhydrite, gypsum, argallite, sandstone, limestone, and dolomite. Measurements were made in holes (110 to 120 mm in diameter) filled with saturated NaCl solution by using a logging radiometer with slow neutron detectors with zinc sulfide and boron (^{10}B). The neutron–neutron logging diagram for extensive probing (60 cm) in the rock salt is fixed by higher thermal neutron values because of the more extensive length of neutron migration than in other associated rocks. The graphs may be used for evaluating inversion probes and for comparison of probe efficiency in neutron–neutron logging. (R.V.J.)

6023 EFFECT OF AGING ON FIXATION OF ^{90}Sr BY SOILS. Schulz, R. K.; Riedel, H. H. (Univ. of California, Berkeley). Soil Sci., 91: 262-4(Apr. 1961).

A knowledge of the chemical distribution of ^{90}Sr that has been introduced into soil is of major importance in assessing the likelihood that the isotope will enter into food chains. Water-soluble or exchangeable ^{90}Sr is much more readily available to plants than nonexchangeable ^{90}Sr. To investigate the possibility that carrier-free ^{90}Sr may become fixed by soils in a nonexchangeable form with the passage of time, 3 soils were analyzed for nonexchangeable ^{90}Sr shortly after addition of the isotope and after aging periods of 2.5 or 3.5 yr. The 3 soils studied were: Hanford very fine sand loam, Yorkville loam, and Columbia very fine sandy loam. In each of the 3 soils nearly all the recently added ^{90}Sr was readily extracted by $SrCl_2$ or $CaCl_2$. When the ^{90}Sr was aged in the soil for $2\frac{1}{2}$ or $3\frac{1}{2}$ years prior to extraction, the per cent that was nonextractable rose significantly. Thus, with the passage of several years a small fixation of ^{90}Sr was found in a nonexchangeable form in soils. This fixation probably takes place, in part, by incorporation in $CaCO_3$ cyrstals when soils contain this material. In

all soils studied, fixation appeared to be caused by entry of the ^{90}Sr into such solid phases as Sr or Ca phosphates or other crystals containing Sr or Ca. (BBB)

6024 MEASUREMENT OF POLONIUM IN THE RANGE OF 10^{-13} CURIES, TRACING BY ^{208}Po, AND APPLICATION TO THE CHRONOLOGY OF ICE. Crozaz, G.; Fabri, P. (Univ. Libre, Brussels). Earth Planet. Sci. Lett., 1: 446-8(Nov. 1966). (In French).

A procedure is described for measuring ^{210}Po in the range of 10^{-13} Ci in water and ice samples. ^{208}Po is used as a tracer in order to check the recovery yield. This procedure is of special interest for dating firn cores by the ^{210}Pb method. It is applied now for the measurement of the snow accumulation rate at the Pole of Relative Inaccessibility (82°07'S. 55°06'E). (auth)

6025 TRINITY WEAPON SITE RADIATION LEVELS. Boland, J. Robert (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Health Phys., 13: 87-8(Jan. 1967).

The results of a radiological survey conducted in the spring of 1961 of the area in the vicinity of the Trinity (Alamogordo) weapon site where the first nuclear weapon was detonated on July 16, 1945, are outlined. This site is within the present boundaries of the White Sands Missile Range. Low levels of residual radioactivity were indicated. These are shown in graphical form. An activity spectrum analysis was also performed on the fused, green, glass-like soil, known as Trinitite. It was concluded that residual radiation at the site will continue to be evident for some years to come (although not very serious from the standpoint of the casual visitor). (UK)

6026 TRANSPORT OF URANIUM IN AQUEOUS SOLUTIONS IN THE FORM OF COMPLEX SILICATE IONS. Ermolaev, N. P.; Zhidikova, A. P.; Zarinskii, V. A. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geochem. Int., 2: 629-41(1965).

Under certain conditions uranium may be transported in nature in the form of an aqueous solution of a hydroxyuranyl silicate complex of the $(UO_2OH)(HSiO_3)$ type. The hydrosilicate ion may be considered either as a group stabilizing the hydroxyuranyl ion in solution or as a ligand of a weak complex. The particle size of this complex is intermediate between that characteristic of ionic solutions and of colloidal suspensions. Uranium migrates in this form in nearly neutral or weakly alkaline solutions, at temperatures up to 200°C, if the concentration of strong electrolytes in the solution is relatively low (not higher than their equilibrium concentration with the uranyl and silicate ions). In carbonate solutions the uranyl silicate complex is decomposed, and the uranyl ion forms a carbonate complex. The uranyl silicate complex is relatively weak and is decomposed with precipitation of uranium and gelatinous silica on considerable decrease in pH or increase in concentration of strong electrolytes. A high sulfate ion concentration or a concentration of carbonate ion equal to or greater than that of the silicate ion results in formation of more stable uranium complexes with those ions. The complex decomposes thermally with precipitation of uranates. (BBB)

6027 URANIUM AND LEAD ISOTOPIC STABILITY IN A METAMICT ZIRCON UNDER EXPERIMENTAL HYDROTHERMAL CONDITIONS. Pidgeon, R. T.; O'Neil, James R.; Silver, Leon T. (California Inst. of Tech., Pasadena). Science, 154: 1538-40 (Dec. 23, 1966). (CALT-427-5).

Disturbance of the uranium–lead isotopic system in a metamict Ceylon zircon has been produced in a 2 molal NaCl solution at 500°C and 1000 bars fluid pressure. Loss of radiogenic lead to the extent of 61% in 13 days was the most significant effect. The experimental results support the episodic rather than continuous lead-loss interpretation of natural zircon systems utilized in geochronology. (auth)

6028 ISOTOPIC COMPOSITION AND ORIGIN OF THE RED SEA AND SALTON SEA GEOTHERMAL BRINES. Craig, H. (Univ. of California, La Jolla, San Diego). Science, 154: 1544-8 (Dec. 23, 1966).

Deuterium and ^{18}O measurements show that the Red Sea and Salton Sea brines are the results of a single process, the leaching of sediments by surface water circulating downward to a geothermal reservoir. The Salton Sea brine is derived from local precipitation but the Red Sea brine originates 1000 km south of its basin, on the shallow sill which controls the circulation of the Red Sea. On this sill sea water penetrates a thick evaporite sequence to a depth of 2000 m, and, driven by its increased density relative to sea water, flows northward to emerge in the brine-filled deeps. (auth)

6029 ALPHA RADIOACTIVITY OF UNKNOWN ORIGIN AND THE DISCOVERY OF A NEW PLEOCHROIC HALO. Gentry, Robert V. (Columbia Union Coll., Takoma Park, Md.). Earth Planet. Sci. Lett., 1: 453-4(Nov. 1966).

Several pleochroic halos of anomalous radii have been found. In general it is not possible to relate these halos to the uranium or thorium decay series alpha emitters. The discovery of a new halo (type G) corroborates previous evidence of presently unknown alpha radioactivity in crustal rocks. (auth)

6030 DISEQUILIBRIUM OF THE ^{238}U SERIES IN BASALT. Somayajulu, B. L. K. (Univ. of California, La Jolla); Tatsumoto, M.; Rosholt, J. N.; Knight, R. J. Earth Planet. Sci. Lett., 1: 387-91(Nov. 1966).

Radioisotope analyses of basalt samples from Hawaii, Japan, and Iwo Jima showed that: ^{234}U and ^{238}U are virtually in radioactive equilibrium: ^{230}Th exceeds equilibrium values in all these samples; ^{210}Pb concentrations range from 10 to 200% of the equilibrium values and average 30% deficient; and ^{226}Ra is probably not in equilibrium with ^{234}U. The source regions of the basalts or magma forming processes are open systems, chemically. The enrichment of some of the uranium–daughter nuclides is insufficient of account for the excess ^{206}Pb in volcanic rocks. The isotopic composition of lead and specific activity of ^{210}Pb in sublimates from Showa-shinzan, Japan are also reported. (auth)

6031 OXYGEN ISOTOPE FRACTIONATION IN IGNEOUS ROCKS. Garlick, G. Donald (Columbia Univ., Palisades, N. Y.). Earth Planet. Sci. Lett., 1: 361-8(Nov. 1966).

The $^{18}O/^{16}O$ ratios of coexisting silicate minerals in igneous and metamorphic rocks are approximately proportional to the following chemical index: (Si + 0.58 Al equivalents/total cation equivalents). Measured phenocryst-groundmass isotopic fractionations in volcanic rocks are negligible (±0.2 per mil) when corrected for differences in their chemical indexes. Apparently, solid and liquid silicates of equivalent chemistry do not fractionate the isotopes of oxygen with respect to one another. Isotopic zoning within phenocrysts and whole-rock isotopic variations accompanying magmatic differentiation are thus expected to be minimal and chiefly due to variations in chemical index. Isotopic fractionations among minerals in plutonic rocks are considerably larger than those found among similar minerals in volcanic rocks. Furthermore, continental plutonic rocks are commonly enriched in ^{18}O relative to oceanic volcanic rocks of equivalent chemistry. (auth)

6032 PROCEEDINGS OF THE CACR SYMPOSIUM ON ATMOSPHERIC CHEMISTRY, CIRCULATION, AND AEROSOLS, AUGUST 18–25, 1965, VISBY, SWEDEN. Bolin, B. (ed.). Tellus, 18: 149-686(1966). (CONF-650845–).

Separate abstracts were prepared for 41 of the 65 papers presented on atmospheric evolution and the chemistry of oxygen, nitrogen, and CO_2; distribution of atmospheric trace constituents; transport in the stratosphere and mesosphere; transport in the lower stratosphere and troposphere; stratospheric aerosols and nuclear debris; tropospheric aerosols and aerosol behavior; new measurement techniques; ions and aerosols; and radon and thoron. Two papers were previously abstracted as 20: 12977 and 35642. (W.D.M.)

For abstracts of individual papers see: 6040–6067 and 6069–6081.

Meteorology

Refer also to abstract 8180.

6033 (IA-1082, pp 235-53) HEALTH PHYSICS. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

Fallout monitoring during 1965 included measurements of gross beta activity of dust samples and gummed tapes at Nabal Soreq, ^{90}Sr and ^{137}Cs and gross beta activity of fallout in rainwater and in dust samples collected at three stations, gamma spectra of various fallout samples, and ^{131}I content in dust, milk, and thyroid samples collected during the period following the Chinese nuclear test of May 14. About 70 milk samples were analyzed for ^{90}Sr and ^{137}Cs content. Soil from 7 sampling sites was analyzed for ^{90}Sr content. Over 100 food samples were analyzed for ^{90}Sr and ^{137}Cs content. Evaluation of procedures for sizing atmospheric aerosols was presented. (R.C.K.)

6034 (MIT-2241-26) PROPAGATORS OF ATMOSPHERIC MOTIONS. Report No. 18. Dickinson, Robert E. (Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology). July 1, 1966. Contract AT(30-1)-2241. 254p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Propagation of linear wave motions in inviscid, stratified, ideal gas atmospheres is described by obtaining the relevant propagators. The transient acoustic oscillations, buoyancy oscillations, and gravity waves for an unbounded non-rotating atmosphere are derived. Introduction of the hydrostatic assumption is found to

eliminate the acoustic and buoyancy oscillations and modify the gravity wave. Time independent potential vorticity motions result for an atmosphere in constant rotation, but these lose their energy by radiation when the influence of the earth's variable vorticity is taken into account. A "filtering" method of synthesizing propagation equations for elementary propagators from their contour integral representations is given. The excitation of the Lamb boundary wave from a point heat source is analyzed. Rossby wave motions and gravity wave motions for an unbounded planar atmosphere are obtained. The quantitative details are obtained by steepest descent integrations, but the "group velocity" concept is adequate for a qualitative description of the resulting motions. Theoretical analysis of forced hydrostatic atmospheric wave motions on a rotating sphere is given. A conservation of energy equation is obtained, several related spectral theorems are established, and the integration of the equation for forced tidal motions on a sphere is discussed. An example of the motion of a convectively unstable atmosphere is given to illustrate instabilities that grow asymptotically. (auth)

6035 (SC-CR-66-2031) PARTICLE FALLOUT AND DISPERSION IN THE ATMOSPHERE. Final Report. Hage, K. D.; Arnason, G.; Bowne, N. E.; Brown, P. S.; Entrekin, H. D.; Levitz, M.; Sekorski, J. A. (Travelers Research Center, Inc., Hartford, Conn.). July 1966. Contracts AT(29-1)-789; 48-2417. 102p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

For Sandia Corp., Albuquerque, N. Mex.

Development of a theoretical model for calculating air and ground concentrations of massive particles (density 1 to 10) of intermediate sizes (1 to 100 microns diameter) released from an instantaneous point or line source at altitudes up to 90 km is described. The model is formulated and programmed for use on a digital computer and was developed to investigate possible hazards associated with aborted missions or orbital-decay reentries of space vehicles possessing nuclear fuels. (auth)

6036 (UCRL-14983) PREDICTING AND SAMPLING NUCLEAR CLOUDS FROM THE VIEWPOINT OF DIFFUSION THEORY. Crawford, Todd V. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 29, 1966. Contract W-7405-eng-48. 42p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The distribution in time and space of pollutants from a large explosion is a function of the motion of the cloud relative to a coordinate system fixed on the earth's surface, and the change of the pollutant distribution within a coordinate system that travels with the cloud center. This study is concerned with only the second problem within a time scale of a few days and a space scale of a few kilometers to a few hundred kilometers. The present network of upper air observation stations is so coarse, relative to the dimensions of the clouds of interest, that it is not possible to predict the relative horizontal movement of the cloud (with respect to the cloud center) in a deterministic manner. Therefore, a diffusion model has to be used. Thus, it is appropriate to examine the consequences of using a diffusion theory on these time and space scales. The frequently observed Gaussian distributions, used in micrometeorological studies of continuous point sources, are a consequence of long sampling time compared to the time scale of diffusion processes. However, kilometer-sized clouds are sampled by aircraft in a time period which is short compared to the time scale of the diffusion processes. Therefore, it should not be expected that any one flight through a cloud would give concentration data, as a function of distance along the flight path, in agreement with the smooth Gaussian type of distributions predicted by diffusion theories. The more the cloud concentration data are smoothed after collection, the more likely is any one cloud's time-and-space history to follow a diffusion theory prediction better than any one cloud. The average of many clouds will fit diffusion theory prediction better than any one cloud. Assuming an idealized Gaussian cloud, a number of numerical calculations are made to illustrate the consequences of different methods of sampling. Along flight path, concentration data needs to be obtained with a spacial resolution equivalent to the standard deviation of the cloud (in distance) at the time of sampling. To investigate diffusion by looking at cloud growth, the isopleth of concentration used to define the cloud boundary must be four to five orders of magnitude below the initial peak concentration, or the isopleth of radioactivity (with a decay proportional to t^{-1}) must be eight to nine orders of magnitude below initial peak concentration. It is suggested that several aircraft be used to sample these clouds. One airplane should keep continuous track of the cloud boundary and direct the sampling efforts of the other aircraft. If careful control of aircraft sampling technique is not maintained, it is unlikely that one will be able to use data to distinguish between the predictions of different diffusion theories. The smoothing problems illustrated by the various numerical computations in this report will give the appearance of slow diffusion. Cloud location problems, effects of mean wind shear, and depletion due to fallout, wipe out, rainout, and washout would give the appearance of fast diffusion. (auth)

6037 RADIOACTIVE DEBRIS INJECTED INTO THE STRATOSPHERE BY THE CHINESE NUCLEAR WEAPON TEST OF MAY 9, 1966. Feely, Herbert W.; Barrientos, Celso; Katzman, David (Isotopes, Inc., Westwood, N. J.). Nature, 212: 1303-4(Dec. 17, 1966).

Filter samples of stratospheric air collected by Rb-57F aircraft in May and June 1966 contained radioactive debris from the May 9, 1966, Chinese nuclear weapon test. The β activities of samples collected at 6 points in the atmosphere from July 1965 to June 1966 are plotted. It appeared that in the stratosphere, the cloud of debris from the Chinese test, as intercepted, was restricted to the lowest layers, below 17 km in the northern polar stratosphere and below 19 km in the tropical stratosphere. Radiochemical analyses of the debris indicated that it was strongly fractionated. (M.C.G.)

6038 ALPHA-ACTIVITY OF HIGHLY RADIOACTIVE FALLOUT PARTICLES. Mamuro, Tetsuo; Matsunami, Tadao (Radiation Center, Osaka). Health Phys., 13: 51-9(Jan. 1967).

Alpha-activities due to ^{239}Pu and ^{240}Pu of the three kinds of highly radioactive fallout particles which originated from a Soviet large scale air burst carried out in autumn 1962, the first Chinese explosion (a small scale land surface burst) and the second Chinese explosion (a small scale air burst), respectively, have been measured α-ray spectrometrically, while the activities of ^{144}Ce and $^{95}Zr + {}^{95}Nb$ have been measured γ-ray spectrometrically. The differences in specific activities and composition ratios of these nuclides which have been found among the three kinds of particles are discussed in connection with the differences in burst conditions of the three explosions from which they originated. The ratio of α-activitity to total activity ($\alpha/\alpha + \beta$) has been found to be considerably smaller in the particles than in the rain-water samples which were collected in the periods just before and after the days when the particles were found and collected. The Pu concentrations in the mean rain-water samples collected in the period from 1962 to 1965 were measured to be about 3×10^{-2} pCi/l. (auth)

6039 RADIOACTIVE RUTHENIUM AND MANGANESE ISOTOPES IN THE ATMOSPHERE. Rao, M. N.; Menon, K. K. (Univ. of Arkansas, Fayetteville). Nature, 213: 26-7(Jan. 7, 1967).

Radioactive debris injected into the atmosphere by ground and air nuclear bursts is well suited for tracing the movements of air masses between the stratosphere and the troposphere. Fission product concentrations and neutron activation are determined in air samples collected at various altitudes and latitudes. The results of analyses for ^{106}Ru and ^{54}Mn for air samples in the northern hemisphere up to 68,000 ft in connection with the Star Dust Program are given. The origins of these activities are discussed, together with applications of the data to air movements. The use of ^{90}Sr and ^{144}Ce in this connection is also being studied. (UK)

6040 IODINE, BROMINE, AND CHLORINE IN WINTER AEROSOLS AND SNOW FROM BARROW, ALASKA. Duce, Robert A.; Winchester, John W.; Van Nahl, Theodore W. (Massachusetts Inst. of Tech., Cambridge). Tellus, 18: 238-48(1966).

Iodine, bromine, and chlorine were determined in atmospheric aerosols and in snow collected in Barrow, Alaska, during January, 1965, by means of neutron activation analysis. Aerosols collected using both an aircraft collector by impaction and a ground-based 1.0 μ Type EA Millipore filter collector show concentrations of Cl to be much more variable than either Br or I, and I/Br points cluster at 0.1 to 0.2 gI/gBr for the filter samples. Cl varies from <0.02 to 4 μg Cl/m^3 STP in the filter samples, and the aircraft concentrations agree with those taken by filter on the same days. Filter Br is 1 to 30 ngBr/m^3 STP and I is 0.3 to 10 ngI/m^3 STP, and the ratios I/Cl and Br/Cl increase sharply with decreasing Cl. Snow samples from the ground have Br/Cl somewhat greater than in seawater, although all halogen concentrations decrease with increasing distance from the sea up to 10 km. Assuming a mixture of undifferentiated sea salt and a more permanent atmospheric component, it is estimated for the atmospheric component in the snows I/Br $\approx$ 0.2. Seawater, sea ice, and related samples were analyzed, and I/Cl = 4×10^{-6} gI/gCl is normal for seawater, although Br/Cl = 3.8×10^{-3} gBr/gCl stands a little high. (auth)

6041 COHERENCE OF IODINE AND BROMINE IN THE ATMOSPHERE OF HAWAII, NORTHERN ALASKA, AND MASSACHUSETTS. Winchester, John W.; Duce, Robert A. (Massachusetts Inst. of Tech., Cambridge). Tellus, 18: 287-92(1966).

Previously reported analyses of rain, snow, aerosols, and gas from Hawaii, Alaska, and Massachusetts, and new analyses of Antarctic and Alaska snow and ice, are compared. Both I and Br

appear to be associated with aerosols of smaller particle sizes and longer residence times than Cl-rich aerosols. In most suites of samples there is a clustering at I/Br ~ 0.1 to 0.2, and Br/Cl exceeds the sea water ratio (3.4×10^{-3}) several-fold. Aerosols collected over open sea water in Hawaii, however, show Br/Cl several-fold lower than in sea water. The latter particles are identified as "sea salt" aerosols whereas the Br-rich aerosols are smaller in size and may be basically different in composition, e.g. ammonium sulfate. It is suggested that Br is "distilled" from the sea spray droplets, possibly by photochemical oxidation to Br_2, and then "condensed" onto the smaller particles, possibly by participating in the oxidation of SO_2 to sulfate. Iodine may engage in similar reactions, and the resulting I and Br-rich particles exhibit a world-wide constancy in I/Br. Precipitation analyses show a similar constancy in I/Br. (auth)

6042 METEORITIC COMPONENT OF STRATOSPHERIC AEROSOLS. Shedlovsky, J. P.; Paisley, S. (National Center for Atmospheric Research, Boulder, Colo.). Tellus, 18: 499-503(1966).

The chemical analysis of aerosols collected at 19 to 21 km altitude on a polystyrene filter is reported. S and/or Cl, Fe, Na and Cr were detected. The mixing ratio of sulfur containing particulates at this altitude is $\leq 2.9 \times 10^{-9}$ g S/g dry air. The Fe/Na ratio is 1.2 ± 1.2 similar to that of crustal rocks. The chondritic meteorite component of the collected Fe and Na is <10%, and the annual influx of submicron chondritic material to the earth is estimated to be $< 9 \times 10^4$ metric tons. (auth)

6043 INFLUENCE OF INVERSIONS UPON PRECIPITATION DEPOSITION OF RADIOACTIVE AEROSOLS. Kruger, Paul (Stanford Univ., Calif.). Tellus, 18: 516-24(1966).

The role of the tropopause as a thermal barrier to aerosol transport and direct stratospheric tapping by precipitation processes has been studied extensively. Several different transport mechanisms across this inversion, including some involving precipitation-scavenging processes, have been postulated. Gradients of radioactive aerosols are also expected across low-level inversions within the troposphere. These are generally more accessible for experimental study. Studies on the meteorological influences on radioactive aerosol deposition by precipitation have involved the presence of inversions, both at the tropopause and at low levels. The inversion aspects of three prior studies are reviewed. The first involves the penetration of the tropopause by convective storms. Radiochemical and radar-meteorological analyses of two severe storms in Oklahoma in May 1963, both of which penetrated to heights above the tropopause, are compared to data for three contemporary convective storms in central Pennsylvania none of which penetrated the tropopause. The second concerns the changes in radioactivity concentration in precipitation associated with the overturning of the marine layer during a Pacific extratropical cyclone sampled at Santa Barbara, California, on February 7, 1962. The third involves an examination of the vertical distribution and transport by air motion and precipitation across the trade wind inversion at Hawaii during periods in 1963 and 1964. (auth)

6044 AEROSOL BEHAVIOUR TRACED BY ARTIFICIAL AND NATURAL RADIOACTIVITY. Storeboe, Per B. (Norwegian Defence Research Establishment, Kjeller). Tellus, 18: 532-40(1966).

Simultaneous daily samples of nuclear bomb debris were statistically analyzed based on the assumption that day-to-day variations are due to compression or dilution of a basic population. Monthly normalized standard deviations are presented from October 1956 to December 1964. Sorting of results into dry and rainy weather collections suggests that the "quantums" of radioactivity of individual particles are greatest when the bomb debris is collected in rain, indicating that most of the collection in rain is due to the larger particles acting as condensation nuclei. Natural aerosols have a similar size range. This suggests a variation of life-time with aerosol size. Some aspects are illustrated by computation of apparent life-time of gross aerosols, when two groups are in steady state with respect to radon daughters. Apparent life-time is shorter for the $^{214}Pb/^{210}Pb$ than for the $^{210}Pb/^{210}Po$ ratio. Published measurements are discussed. (auth)

6045 STUDY OF ARTIFICIAL RADIOACTIVITY FIXED ON ATMOSPHERIC CONDENSATION NUCLEI AT GROUND LEVEL. Renoux, A. (Faculte des Sciences, Paris. CEN, Fontenay-aux-Roses, France). Tellus, 18: 610-18(1966). (In French).

The techniques established for the study of radon and thoron daughters were applied to the determination of γ activity on particles of a radius below 2×10^{-6} cm at ground level. Long time samplings were used and the collections were measured with a γ multichannel spectrometer. Experimental results allow a verification that γ activity fixed on particles with radii below 2×10^{-6} cm represents an average of 16% of the total artificial radioactivity. (auth)

6046 NUMERICAL MODELS OF DIFFUSION AND RAINOUT OF STRATOSPHERIC RADIOACTIVE MATERIALS. Davidson, B.; Friend, J. P.; Seitz, H. (Isotopes, Inc., Westwood, N. J.). Tellus, 18: 301-15(1966).

A numerical model in two dimensions capable of simulating diffusion, transport, particle fall velocity, and tropospheric rainout is described. The model incorporates a general anisotropic diffusion process. Rainout is simulated by fractional removal of debris at selected rain "formation" levels; the fraction removed at any latitude is proportional to the observed rainfall at that latitude. The transport terms are neglected and an attempt is made to reproduce available data with a diffusion–rainout–settling velocity model. The parameters of the model are varied in an attempt to reproduce quantitatively the known behavior of ^{185}W injections in equatorial regions and, at least qualitatively, the behavior of high latitude stratospheric injections. Three types of models are described; they are characterized respectively by the principal diffusion axis being (a) along a horizontal surface, (b) along surfaces of constant potential temperature, and (c) along surfaces of constant potential vorticity. All three types can reproduce the latitudinal variation of rainout in a satisfactory manner, but only the third can reproduce the observed pattern of concentration in the stratosphere. The third type yields satisfactory results using lines of constant potential vorticity or using lines parallel to the tropopause as the principal axis of diffusion. (auth)

6047 METEOROLOGICAL STUDY OF THE COURSE OF RADIOACTIVE DEBRIS. Tanaevsky, O. (Faculte des Sciences, Paris); Blanchet, J. Tellus, 18: 434-40(1966).

An attempt was made to follow the course of radioactive debris produced during nuclear explosions by drawing trajectory lines where the probability of finding the radioactive cloud is greatest. The paths were circumpolar and the highest speeds of displacement correspond to the speeds of polar jets. The course of these hypothetical trajectories was observed at several stations. (auth)

6048 ^{210}Pb AND ^{210}Po IN THE ATMOSPHERE. Peirson, D. H.; Cambray, R. S.; Spicer, G. S. (Atomic Energy Research Establishment, Harwell, Eng.). Tellus, 18: 427-33(1966).

The concentration of ^{210}Pb was measured at several altitudes in the atmosphere over the United Kingdom during 1958. The gradient into the lower stratosphere was less steep than observed by Burton & Stewart (1960) and conformed to the diffusion models of Jacobi & Andre (1963) for the case of short washout times, and Machta (1960). The concentrations of ^{210}Pb and ^{210}Po in surface air and ^{210}Pb in rainwater have been measured continuously since 1961. The ratio of $^{210}Po/^{210}Pb$ exhibits a seasonal variation during 1962 and 1963: this might be attributed to artificial production of ^{210}Pb during the weapon tests of 1961 to 1962. An estimate was made of the global deposition of ^{210}Pb. (auth)

6049 POSSIBILITIES OF USING ^{210}Pb AS AN ATMOSPHERIC TRACER. Lambert, G.; Ardouin, B.; Nezami, M.; Polian, G. (CEN, Saclay, France). Tellus, 18: 421-6(1966).

The high sensitivity of ^{210}Pb measurement through ^{210}Po enables the dating of the neve layers of the Antarctic continent. Some correlations between the concentration of ^{210}Pb in the snow and solar activity are given. The study of the atmospheric concentration of ^{210}Pb above the oceans proved the stratospheric origin of this nuclide in these regions, the former correlations are therefore due to a possible action of the sun's corpuscular radiations on the stratosphere-troposphere transfers. (auth)

6050 ARTIFICIAL RADIOACTIVITY, OZONE AND VOLCANIC DUST AS ATMOSPHERIC TRACERS IN THE SOUTHERN HEMISPHERE. Dyer, A. J. (CSIRO, Aspendale, Australia). Tellus, 18: 416-20(1966).

The use of artificial radioactivity measurements to study atmospheric transfer processes is particularly attractive in the Southern Hemisphere because of the absence of atomic testing at other than equatorial regions. Observations of volcanic dust at Aspendale (38°S) following the Bali eruption of 1963 show that the bulk of the material arrived in these latitudes after about six months at a height of 20 km. Simple diffusion theory would imply a horizontal transfer coefficient of 4×10^9 cm^2 sec^{-1}. A similar value would be inferred from the initial appearance of artificial radioactivity in rainfall following the 1962 series of atomic tests at the equator. However, stratospheric sampling carried out at Mildura (35°S) indicate the poleward transfer of fission products to be rather complex. The first arrival after about six months is well demonstrated at a height of 18 km; but other, stronger centers of activity appeared at 33 km after 6 to 9 months, and at 25 km after 12 months. Seasonal effects are observed in all tracers,

but with the various maxima occurring at slightly different times of the year, presumably due to the different heights involved in transfer from an equatorial reservoir. (auth)

6051 INVESTIGATION OF THE RADIOACTIVE AEROSOL DISTRIBUTION OVER OCEANS AND SOME PROBLEMS OF THE LATITUDINAL EXCHANGE IN THE TROPICAL ZONE. Dmitrieva, G. V.; Krasnopevtsev, Yu. V.; Lukyanov, V. V.; Malakhov, S. G. (Hydrometeorological Service, Moscow). Tellus, 18: 407-15(1966).

On the basis of data from Soviet research ships six cases of radioactive fission product distribution in the lower layer of the air in different meridional zones of the globe were considered. An attempt was made to reveal some circulation conditions of air propagation from the middle latitudes into the tropics and the other hemisphere (in the surface layer). A problem on the influence of polar intrusions on the evolution of intertropical convergence zone was discussed briefly. (auth)

6052 STRATOSPHERIC CIRCULATION STUDIES BASED ON NATURAL AND ARTIFICIAL RADIOACTIVE TRACER ELEMENTS. Bhandari, N.; Lal, D.; Rama (Tata Inst. of Fundamental Research, Bombay). Tellus, 18: 391-406(1966).

The nature of large scale stratospheric circulation was studied using the cosmic ray produced isotopes ^{32}P, ^{7}Be, ^{35}S, and ^{22}Na as tracers. Supplementary information obtained from observations of the distribution of the bomb-produced ^{22}Na and ^{210}Pb was taken into account. The activities of these tracer elements were measured in the stratospheric air, up to altitudes of 20 km, during 1960 to 1964. Data are fairly extensive for studying the characteristics of the mean circulation in the stratosphere as well as seasonal changes in patterns of mixing/transport of air in certain regions of the stratosphere. (W.D.M.)

6053 RADIOACTIVE DEBRIS AS A TRACER FOR INVESTIGATING STRATOSPHERIC MOTIONS. List, Robert J. (Environmental Science Services Administration, Washington, D. C.); Salter, Leonard P.; Telegadas, Kosta. Tellus, 18: 345-54(1966).

Two meteorologically interesting radioactive tracers, ^{109}Cd injected in 1962 at 400 km by a rocket-borne nuclear device and ^{238}Pu resulting from the reentry burnup in 1964 of a nuclear powered satellite in the 40 to 60 km altitude range, were examined and compared with the results of the ^{102}Rh experiment conducted in 1958. Although detonated at 17°N, the maximum concentration of ^{109}Cd was detected by the high-altitude balloon samples collected at 34°S. It first appeared at the highest altitude sampled, 32 km, and subsequently seemed to propagate downward at about 1.5 km per month. A second similar surge of ^{109}Cd was observed at 34°S about a year later. Maximum concentration of ^{238}Pu also occurred at 32 km at 34°S. Slightly lower concentrations were observed at this altitude in northern temperate and polar regions while concentrations near the equator were an order of magnitude lower. Although the ^{238}Pu distribution could result from either diffusive mixing along sloping surfaces or from meridional transport, the two surges of ^{109}Cd suggest poleward transport and subsequent reinforcement from a polar reservoir. (auth)

6054 SIZE DISTRIBUTION AND INTERACTION OF RADIOACTIVE AND NATURAL AEROSOLS IN THE STRATOSPHERE. Martell, E. A. (National Center for Atmospheric Research, Boulder, Colo.). Tellus, 18: 486-98(1966).

Artificial radioactivity which persists in the stratosphere on a time scale of years is shown to be associated with particles below 0.02 μ radius above 27 km and with particles very nearly 0.1 μ radius between 21 km and the tropopause. Assuming the artificial radioactivity to be associated with natural aerosols at each level, the radioactive particle size data provide insight on the size distribution of micrometeorites and other particulates in the upper stratosphere and their interaction with sulfate particles in the lower stratosphere. The decrease in specific radioactivity with increased sulfate particle radius near 20 km suggests that the photochemical oxidation of SO_2 may not be the important mechanism for large particle formation at this level. Chemical factors and residence time considerations support the view that Aitken nuclei in the upper troposphere are sulfate particles of sufficient size and population to account for the production of large sulfate particles near and above the tropopause by Aitken nuclei coagulation. Approximate estimation of the total sulfate mixing ratio with altitude above 5 km indicates a broad maximum in the upper troposphere. Photochemical and radiochemical evidence for the rapid oxidation of SO_2 in the stratosphere reinforces these views. It is tentatively concluded that Aitken particles in the troposphere account for most of the sulfate in the atmosphere and that there is no stratospheric sulfate layer but only a stratospheric "large particle" layer. (auth)

6055 SIZE DISTRIBUTION OF RADIOACTIVE PARTICLES FROM NUCLEAR WEAPON TESTS AND THEIR TRANSPORT IN THE ATMOSPHERE. Gasiev, Y. I.; Malakhov, S. G.; Nazarov, L. E.; Silantiev, A. N. Tellus, 18: 474-85(1966).

In 1964 to 1965 in the Moscow region radioactive particle size distribution was studied in the ground layer of the atmosphere and in December, 1964, measurements were carried out at 5 to 6 km as well. Four kinds of radioactive aerosol size distribution variations were observed. In the troposphere at 5 to 6 km radioactive particles were on the average smaller than in the ground layer. The mean diameter of particles-carriers of ^{137}Cs at 5 to 6 km was greater than that of particles-carriers of ^{144}Ce. This difference was averaged in the samples, taken at the ground surface. Analysis of literature data on variations of ratios of various isotope concentrations was made. It shows that radioactive particle size distribution significantly affects the transport of these particles in the atmosphere, especially in the higher layers of the stratosphere and in the mesosphere. (auth)

6056 OBSERVATIONS ON THE PARTICLE PROPERTIES OF NUCLEAR DEBRIS IN THE UPPER ATMOSPHERE. Edvarson, K.; Sisefsky, J. (Research Inst. of National Defence, Stockholm). Tellus, 18: 457-64(1966).

By means of an autoradiographic method, the concentration of nuclear debris particles of different radioactivity content was studied. The material consisted of air-filter samples taken at an altitude of 8 to 12 km in 1961 to 1963. In the periods studied the concentration of particles with diameters larger than about 0.5 μm was of the order 10 to 100 kg^{-1} in the lower stratosphere and decreased slowly with time. It was found that the content of such particles relative to the total radioactivity decreases fairly rapidly. It was also observed that the relative concentration of larger particles is higher in the tropospheric samples than in the stratospheric. (auth)

6057 SURFACE OZONE AND ARTIFICIAL β^- ACTIVITY IN DRESDEN-WAHNSDORF. Warmbt, Wolfgang (Meteorological Observatory, Dresden). Tellus, 18: 441-50(1966).

In the German Democratic Republic ozone and radioactivity network, simultaneous measurements of surface ozone were made at 5 stations by the chemical method of Cauer and by artificial activity by filter sampling. The daily maximum values of surface ozone and the daily mean of radioactivity show relations in their seasonal trend. The results of these investigations at Dresden-Wahnsdorf station (51.1°N, 13.7°E) are discussed. In years without nuclear tests (1963 and 1964) there was a statistically significant positive correlation between ozone and radioactivity from March until September. In a year with fresh fission production (1962) there was such a correlation during the time of decreasing activity from June until August. From October until February the correlation in the year 1962 to 1964 was mostly negative, in part statistically insignificant. The relation of ozone and radioactivity data for large-scale weather systems and during periods with and without precipitation was investigated for daily deviations of ozone and radioactivity from their seasonal trend, smoothed by overlapping ten-day averages. Deviations which were higher or lower than the single value of the standard deviation as well as averaged values of the deviation as well as averaged values of the deviations are discussed. On days with southerly air flow in the 500 mb region there was an increase of ozone and radioactivity; there was a decrease on days with northerly air flow. The influence of wash out was indicated by an increase during dry weather periods and a decrease during periods with precipitation. From March until September there are similar deviations from the seasonal trend for both ozone and radioactivity. From October until February there was an inverse trend due to the influence of large-scale weather systems with a stable stratification (central high pressure systems). Ozone decreases due to the accumulation of reducing trace constituents in surface air, while radioactivity decreases due to the increased rate of scavenging by dust. (auth)

6058 COSMIC RAY PRODUCED ^{28}Mg, ^{31}Si, ^{38}S, ^{38}Cl, ^{34m}Cl, AND OTHER SHORT-LIVED RADIOISOTOPES IN WET PRECIPITATION. Bhandari, N.; Bhat, S. G.; Kharkar, D. P.; Krishna Swamy, S.; Lal, D.; Tamhane, A. S. (Tata Inst. of Fundamental Research, Bombay). Tellus, 18: 504-15(1966).

The concentrations of seven radioisotopes, expected to be produced in the troposphere by interactions of secondary cosmic rays with atmospheric nuclei, have been measured in "fresh" rain collections. The half-lives of these isotopes range from about half an hour to a day. The procedures developed for rapid, specific and sensitive analyses of these nuclides are discussed. The nature of cosmic ray secondary particles responsible for the production of these short-lived radionuclides in the troposphere is discussed. Isotope production is found to vary strongly with altitude in the troposphere; it increases by a factor of two every 1.5 to 2 km depending on the radioisotope under question. This fact combined

with the availability of several isotopes of half-lives ranging from about half an hour to a day leads to the possibility of using them as tracers for studying short-term tropospheric processes, e.g., those occurring prior to and during condensation in a precipitating cloud. The implications of the present measurements are discussed. (auth)

6059 TRANSPORT AND FALLOUT OF STRATOSPHERIC RADIOACTIVE DEBRIS. Feely, H. W.; Seitz, H.; Lagomarsino, R. J.; Biscaye, P. E. (Isotopes, Inc., Westwood, N. J.). Tellus, 18: 316-28(1966).

The average stratospheric residence half-time of particulate radioactive debris, as represented by ^{90}Sr and ^{54}Mn, was approximately 10 months during the two years following the last atmospheric tests of high yield nuclear weapons. During this interval, the ^{14}C which was produced artificially by nuclear weapons tests showed a stratospheric residence half-time which increased with time, but averaged about 18 months. It was suggested that the stratospheric residence half-time of particulate debris did not increase significantly during 1963 until early 1965 because in the upper stratosphere, above 20 km, the rate of particle settling of the debris exceeded the rate of upward diffusion, and as a result, this debris remained highly concentrated in the lower stratosphere throughout this period. It was also suggested that the relatively more rapid meridional movement of particulate debris, compared to the movement of ^{14}C, into the stratosphere of the Southern Hemisphere during the second half of 1963 resulted to some extent from the partial separation of the particulate debris from the ^{14}C in the equatorial stratosphere as a result of particle settling. (auth)

6060 TRANSPORT OF IODINE FROM ATMOSPHERE TO GROUND. Chamberlain, A. C.; Chadwick, R. C. (Atomic Energy Research Establishment, Harwell, Eng.). Tellus, 18: 226-37(1966). (AERE-R-4870).

Three methods have been used to measure the velocity of deposition of iodine to grassland. For average conditions the results are: field experiments, $v_g = 1$ cm/sec; analysis of fallout data, $v_g = 0.5$ cm/sec; analysis of stable iodine measurements $v_g = 0.16$ cm/sec. The varying physical-chemical state of the iodine accounts for the variation. An analysis is made of the contributions of various parts of the boundary layer to the resistance to transport of gaseous elemental iodine to grass. (auth)

6061 THE ^{32}Si FALLOUT IN SCANDINAVIA. A NEW METHOD FOR ICE DATING. Dansgaard, W. (Univ. of Copenhagen); Clausen, H. B.; Aarkrog, A. Tellus, 18: 187-91(1966).

The specific ^{32}Si activity of air in Denmark showed a seasonal variation by a factor of 5 in 1963. The total ^{32}Si fallout was 5.5×10^{-5} dpm cm^{-2} year^{-1} in the period Sept. 64 to Sept. 65. Measurements on accumulated snow and old glacier ice in Norway show ^{32}Si as an usable element for dating of up to 2000 to 3000 years old ice. (auth)

6062 VARIATION IN ^{14}C CONCENTRATION IN THE ATMOSPHERE DURING THE LAST SEVERAL YEARS. Nydal, Reidar (Norwegian Inst. of Tech., Trondheim). Tellus, 18: 271-9 (1966).

Variation in ^{14}C concentration with time at various northern latitudes from 9°N to 78°N has been studied in the troposphere mainly since 1963. Sampling was later extended to 21°S. During 1965 sampling was also performed at 63°N at an altitude of 13 km. Tropospheric data have been compared with the HASL measurements at an altitude of 20 km. It appears that the stratosphere at this height mixes very rapidly in the latitudinal direction at latitudes above 30°N. The diffusion coefficient for turbulent mixing in this region may be of the same order as that of the troposphere (10^{10} to 10^{11} cm^2/sec). In 1963 there seems to be a decrease in exchange rate below about 30°N, both within the stratosphere (20 km altitude) and within the troposphere. In summer 1964, however, this "barriere" in the troposphere is less convincing because all the ^{14}C peaks occur nearly simultaneously from 9°N to 78°N. The peak at Dakar (15°N) is even higher than several peaks farther north. The impression is that the simultaneous occurring ^{14}C peaks in the troposphere in summer at various northern latitudes are partly due to a simultaneous removal of ^{14}C from the stratosphere to the troposphere at the respective latitudes. It turns out that ^{14}C from polar explosions in 1962 is transferred to the lower and southern latitudes both through the troposphere and through the stratosphere. ^{14}C transfer through the last one seems to be important. (auth)

6063 NEW TRITIUM AND DEUTERIUM MEASUREMENTS IN ATMOSPHERIC HYDROGEN. Gonsior, Bernhard (Univ., Cologne); Friedman, Irving; Lindenmayr, Georg. Tellus, 18: 256-61(1966).

Tritium and deuterium analyses were made on samples of atmospheric hydrogen collected in 1961. A positive correlation exists between tritium and deuterium. The heaviest samples yield a value of about +18‰ standard mean ocean water (SMOW) for atmospheric hydrogen. The deuterium concentration of the industrial hydrogen varies from −18‰ to −22‰. The industrial hydrogen is partially ascribed to hydrogen from automobile exhaust gas. The corrected tritium concentration in atmospheric hydrogen continues to increase, doubling every two years. Several large tritium peaks are correlated with Soviet weapons tests. (auth)

6064 TRITIUM AND DEUTERIUM IN ATMOSPHERIC HYDROGEN. Ehhalt, D. H. (National Center for Atmospheric Research, Boulder, Colo.). Tellus, 18: 249-55(1966).

After correcting the tritium content of atmospheric molecular hydrogen samples for contamination by industrial hydrogen, the increases in the tritium content of atmospheric hydrogen over the past ten years are discussed. It is found that the increases in the tritium concentration occur in steps about 2 to 2.5 years after major thermonuclear test series. It is concluded that most of the HT formed by thermonuclear explosions is injected into upper stratospheric levels and subsequently follows the mixing pattern observed for the high-altitude tracer rhodium-102. (auth)

6065 MEASUREMENT OF RADIOACTIVE XENON IN THE ATMOSPHERE. Schoelch, J.; Stich, W.; Muennich, K. O. (Zweites Physikalisches Institut, Heidelberg). Tellus, 18: 298-300(1966).

In the course of a previous investigation, an attempt was made to measure the ^{133}Xe released to the atmosphere by bomb tests during 1961. Because the raw samples contained krypton, argon, oxygen, and radon, only an upper limit for the Xe activity could be given. A gas chromatographic method for separation of Xe from Kr and Rn was developed. The ^{133}Xe assay was made in low-level proportional counters normally used for ^{14}C. Results are shown for the Chinese bomb test of May 14, 1965. (W.D.M.)

6066 RADIOCARBON VARIATIONS IN THE ATMOSPHERE. Olsson, Ingrid U.; Karlen, Ingvar; Stenberg, Allan (Uppsala Univ.). Tellus, 18: 293-7(1966).

Radiocarbon, produced by nuclear explosions, is one of the tracers which is suitable for studies of the mixture of the atmosphere. A model is discussed which was developed for the mixing in the troposphere assuming that the ^{14}C-rich carbon dioxide was injected from the stratosphere into the troposphere rather close to the North Pole and then diffused along the surface of the earth. Collection of data at different points is considered and results are discussed. (W.D.M.)

6067 QUANTITATIVE INVESTIGATION OF STRATOSPHERIC MIXING PROCESSES BY MEANS OF LONG LIVED RADON DECAY PRODUCTS. Karol, I. L. (Hydrometeorological Service, Moscow). Tellus, 18: 337-44(1966).

A model of tracer transport process in the meridional plane of lower stratosphere was briefly outlined and the corresponding partial differential equation for tracer concentration was deduced. For the long lived radon daughters (^{210}Pb and ^{210}Po) in the Northern Hemisphere stratosphere such equations can be simplified to one dimensional stationary form, describing the quasivertical transport of these isotopes. The mean values of quasivertical velocity and turbulent diffusion coefficient in the lower stratosphere of different latitudes of Northern Hemisphere are estimated by comparison of last equation solutions with the published results of aircraft measurements of ^{210}Pb and ^{210}Po concentration in 1961 and 1962. These estimated values agree with the known qualitative ideas on latitudinal and seasonal changes of the stratospheric mixing intensity. (auth)

6068 NATURAL SOURCES OF AIR POLLUTION. Jacobson, Alvin R. (Columbia Univ., New York). pp 175-208 of Air Pollution, Vol. 2. Stern, Arthur C. (ed.). New York, Academic Press, 1962.

Levels of natural radioactivity in the air are considered, among other sources of air pollution, in this survey. Of the different kinds of elements found in the earth's crust, approximately one-sixth is radioactive. The principal radionuclides are ^{14}C, ^{40}K, ^{87}Rb, ^{138}La, ^{147}Sm, ^{176}Lu, ^{187}Re, and elements above 83, which constitute the natural decay series: U, Th, Ac, and Np Of these 16 radionuclides, only the members of the U and Th series, plus ^{40}K, contribute significantly to external background radiation. The background radiation intensity under various conditions is estimated. How the concentration of the radioactive gases in the air depends on location and upon atmospheric and other conditions is discussed. For instance, the concentration of Rn and thoron in air is less on days when snow is covering the ground, because the snow interferes with the free escape of these gases from the ground. The concentration also varies inversely with air move-

ment, being at higher levels under stable atmospheric conditions and at lower concentrations with increasing air movement. Data on radon measurements made in various parts of the world are given. The contribution of cosmic rays to natural radiation exposure of man is examined. Such radiation, mainly protons, reach the earth's surface at a rate of about one/cm^2/min at latitudes greater than 50°. Because the earth's magnetic field deflects these particles, only those with the highest energies penetrate the mid-latitudes. Studies made at high elevations indicated that a total of about 10^{20} particles falls on earth per min. These particles are important in air pollution as condensation nuclei and in promoting atmospheric chemical reactions that produce still more nuclei. (BBB)

6069 ^{7}Be AND ^{32}P IN GROUND LEVEL AIR. Aegerter, S. (Univ. of Bern); Bhandari, N.; Rama; Tamhane, A. S. Tellus, 18: 212-15(1966).

Weekly samples of dust collected from ground level air at Bern (47°N) were analyzed for their contents of cosmic ray produced ^{7}Be and ^{32}P during January to September 1965. The observed ratios of ^{7}Be/^{32}P place a limit on the spring influx of stratospheric air. The pronounced spring maximum in ^{7}Be concentration in ground level air, observed by some investigators at temperate and high latitudes is, to a large part, a manifestation of other meteorological factors, e.g., better vertical mixing within the troposphere, rather than due to a large influx of air from the stratosphere. (auth)

6070 A NEW METHOD OF CONTINUOUS MEASUREMENTS OF RADON (^{222}Rn) AND THORON (^{220}Rn) IN THE ATMOSPHERE. Israeel, H. (Rheinisch-Westfaelische Technische Hochschule, Aachen); Israeel, G. W. Tellus, 18: 557-61(1966).

To achieve continuous measurements, an aspiration process was developed, permitting a direct measurement of the radon (^{222}Rn) and thoron (^{220}Rn) contributions to the ionization. After passing through a filter that holds back all aerosols and radon and thoron daughter ions, the air streams through an approximately 300 liter ionization chamber. The current, measured with a vibrating reed electrometer, is composed of three parts: background, radon contribution, and thoron contribution, with each component resolved by appropriate methods. The sensitivity limit amounts to some 0.8×10^{-14} Ci/l for radon and 0.5×10^{-14} Ci/l for thoron with a resolution time of about 220 sec. The principle of measurement and its use for the determination of the radon and thoron content of the lower atmosphere are considered. (auth)

6071 STUDY OF THE INTENSITY VARIATIONS OF IONIZATION BY α AND γ NEAR THE GROUND. Grevet, Philippe (Faculte des Sciences, Paris). Tellus, 18: 587-92(1966). (In French).

The variations of ionization produced in the air, near the ground, by α and γ radiation are considered. The equipment used consisted of two chambers of 120 liters: one, hermetically sealed, detected the component γ; the other, with circulation of ambient air, detected α plus γ, which permitted the α component to be estimated. The chambers and the electronic measuring devices were designed for permanent operation in open air. Another chamber, without wall, also permits the direct estimation of the total intensity of ionization and to deduct from it an approximate value of component β. A series of recordings have been made around Saclay where natural radioactivity is at an average level and also where the level of radioactivity is either low or high (near the sea and in the mining branch of the E.A.C.). It is thus possible to make visible the variations of the component γ in relation to the location where the measurements take place (from 3.7 to 6.3 I/$cm^3 \cdot$s) and the very great variations of component α at the same location (for instance, from 1.5 to 45 I/$cm^3 \cdot$s at Saclay). It is then possible to show that the variations of this component are accurately tied to the values of different meteorological parameters, e.g., rain, fog, pressure, wind, and gradient of temperature. (auth)

6072 BEHAVIOR OF DESCENDENTS OF RADON AND THORON IN ENRICHED ATMOSPHERE. Madelaine, Guy (CEN, Fontenay-aux-Roses, France). Tellus, 18: 593-7(1966). (In French).

The behavior of small radioactive ions resulting from filtered radon or thoron enriched air is studied. It was shown that these particles which initially have an electric load disappear and are replaced by electrically neutral particles, the size of which is studied to a base of time. (auth)

6073 STUDY OF RADIOACTIVE CONDENSATION NUCLEI OF THE ATMOSPHERE. Renoux, A. (Faculte des Sciences, Paris. CEN, Fontenay-aux-Roses, France). Tellus, 18: 598-609(1966). (In French).

A comparative study was made between the radon and thoron decay products in the atmosphere, by means of α radiation counting, using Zeleny tubes, a diffusion battery, or paper or membrane filters for sample collection. Some of the characteristic properties of the radioactive ions are studied with mobilities above 10^{-3} cm^2 sec^{-1} V^{-1}, radius below 2×10^{-6} cm. Neutral radioactive condensation nuclei are measured by means of a diffusion battery. The average air concentrations of radon and thoron are determined. The results indicate that for the radon daughters, as well as the thoron daughters, about 42% of the total α activity is found on particles having a radius less than 2×10^{-6} cm. A theoretical discussion of the experimental results is given. (auth)

6074 MEASUREMENT OF THE DIFFUSION OF RADON, THORON, AND THEIR RADIOACTIVE DAUGHTER PRODUCTS IN THE LOWER LAYERS OF THE EARTH'S ATMOSPHERE. Fontan, Jacques; Birot, Andre; Blanc, Daniel; Bouville, Andre; Druilhet, Aime (Nuclear Physics Center, Toulouse). Tellus, 18: 623-32(1966).

The diffusion of radon, thoron, and their radioactive daughter products in the lower strata of the atmosphere in relation to the variations of certain meteorological parameters was studied with the object of a possible future application to the measurement of the pollution and the diffusion of the air. The results are given of measurements taken between 0 and 30 m in altitude for the study of the vertical distribution of natural radioactivity, and in different regions in order to define the influence of certain local parameters. The study of vertical distribution was carried out at the National Meteorological Observatory in Magny-les-Hameaux (Seine-et-Oise). A tower 30 m high permitted air samples to be taken continuously at several heights above the ground. The concentrations of radon, thoron, and the daughter products of these gases were measured. The variations in the concentrations and in the radioactive equilibrium between gas and daughter products are related to the variations of meteorological parameters and, in particular, to the diffusitivity of the air. (auth)

6075 METEOROLOGICAL INFLUENCES ON THE THORON (^{220}Rn) CONTENT OF THE ATMOSPHERE. Israeel, Gerhard W. (Technische Hochschule, Aachen). Tellus, 18: 633-7(1966).

With new equipment allowing the continuous recording of the atmospheric thoron content with a sensitivity of 0.5×10^{-14} Ci/l and a resolution time of 220 sec, thoron was measured at different levels between 1 and 8 m for several months and related to meteorological variables. By studying the dependence on the wind direction and the increase with height of the thoron concentration, the homogeneity of the thoron exhalation in the near surroundings of the measuring place at Mainflingen could be verified. By comparing the decrease of thoron with height with the theory the eddy diffusion coefficient K was determined. It was found that, on an average, K increases linearly with height between 1 and 8 m, and that it is proportional to the mean wind velocity $\bar{u}$. The average eddy diffusion coefficients elaborated from the results of thoron measurements are compared with the corresponding diffusion coefficients of momentum having been calculated from the wind profile. (auth)

6076 RESULTS OF CONTINUOUS MEASUREMENTS OF RADON AND ITS DECAY PRODUCTS IN THE LOWER ATMOSPHERE. Israeel, H. (Technische Hochschule, Aachen); Horbert, M.; Israeel, G. W. Tellus, 18: 638-42(1966).

With a new continuous measurement method, the radon content of the atmosphere at different levels above ground between 0.5 and 4 m was recorded at Aachen, Germany. Evaluation of simultaneous measurements of the radon daughters with a stepwise progressive filter showed a close relation between radon and its daughters and the meteorological factors at the measuring place. Questions discussed include the daily variations of the radon concentration in relation to the exchange, the radioactive equilibrium of radon and its daughters at different heights, and influences of the wind direction. It was found that during temperature inversions the concentration of radon and its daughters was enlarged while on overcast days the mean daily variation of both the radon and the radon daughter concentration was smaller. Moreover, the radon and thoron daughters were correlated with the dust content of the air. (auth)

6077 DIURNAL VARIATIONS OF RADON AND THORON DECAY PRODUCT CONCENTRATIONS IN THE SURFACE LAYER OF THE ATMOSPHERE AND THEIR WASHOUT BY PRECIPITATIONS. Malakhov, S. G.; Bakulin, V. N.; Dmitrieva, G. V.; Kirichenko, L. V.; Ssissigina, T. I.; Starikov, B. G. (Hydrometeorological Service, Moscow). Tellus, 18: 643-54(1966).

Data on diurnal variations of radon and thoron decay product concentrations in the surface layer of the atmosphere in the Moscow region are given. It was noted that the maximum of radon exhalation from the soil occurred at night. (Measurements were carried out in summer in dry weather.) The strongest upset of radioactive equilibrium between radon daughter products was

observed in the first half of night and in the day-time. From the degree of nonequilibrium between $^{218}Po:^{214}Pb:^{214}Bi$ during the rain the constant of their washout from the lower layer of the troposphere was estimated. The effect of radon and thoron exhalation variations on variations of their concentrations in the surface layer of the atmosphere was considered theoretically. (auth)

6078 SOIL CONCENTRATIONS OF EMANATING ^{226}Ra AND THE EMANATION OF ^{222}Rn FROM SOILS AND PLANTS. Pearson, John E.; Jones, Gary E. (Univ. of Illinois, Urbana). Tellus, 18: 655-62(1966).

The emanation of radon-222 from soils has been studied. Factors investigated which affect the rate of emanation include wind speeds across the surface, atmospheric turbulence, soil moisture, soil type and location. Values of emanation and concomitant variation in these factors are reported. An investigation of radon-222 release from leaf surfaces has been initiated; preliminary results of this study are reported. Measured values of radium-226 in the soil capable of giving rise to diffusing radon were found to vary 70-fold in different geological regions but were uniform in Champaign County, Illinois, the content being $(0.64 \pm 0.09) \times 10^{-12}$ grams of "emanating radium-226" per gram of soil. The emanation rate of radon-222 from soils into the atmosphere varied 1000-fold among geographical regions but was shown to be uniform in Champaign County, averaging $(140 \pm 73) \times 10^{-18}$ Ci/cm^2/sec. The findings of the research indicate that radon-222 may be used successfully as a cost-free tracer in studies of vertical diffusion in Champaign County, Illinois. (auth)

6079 TEMPORAL AND SPATIAL VARIATIONS OF THE CONCENTRATION OF THE SHORT-LIVED DECAY PRODUCTS OF RADON IN THE LOWER ATMOSPHERE. Servant, J. (Centre National de la Recherche Scientifique, Gif-sur-Yvette, France). Tellus, 18: 663-71(1966).

The study of natural radioactivity in the lower atmosphere will provide information on turbulent diffusion and transport of air masses in the lower atmosphere. A study of natural radioactivity of the atmosphere above a plateau and measurements at different latitudes and longitudes over the continents and the oceans, to obtain the general distribution of the radioactivity in the lower atmosphere were made. It was found that the radioactivity of the air is much more important over the plateau than over the oceans (100 and 6×10^{-12} Ci m^{-3}, respectively) and more important over the oceans in the Northern Hemisphere than in the Southern Hemisphere (6 and 1.5×10^{-12} Ci m^{-3}, respectively). From these results it was possible, with the aid of natural radioactivity, to identify air masses and to follow the vertical and horizontal diffusions in a given mass of air. (auth)

6080 A STUDY OF THE MECHANISM OF FORMATION OF RADON DAUGHTER AEROSOLS. Vohra, K. G.; Subbaramu, M. C.; Mohan Rao, A. M. (Atomic Energy Establishment, Trombay, India). Tellus, 18: 672-8(1966).

The formation of radon daughter aerosols in air is found to be markedly influenced by the presence of charges and vapors. Experiments have been carried out with natural radon in the air to show that radon daughter products behave as single ions of high mobility in filtered dry air whereas they are attached to cluster aerosols formed in the presence of certain charges and vapors. In these experiments the cluster aerosols have been formed with ethanol vapor in the presence of small negative ions. Knowledge of this mechanism of attachment of radon daughters to cluster aerosols has also been used for the estimation of airborne radon. The radioactivity of these aerosols is studied by filtration through membrane filters. The degree of equilibrium between radon and its daughters in atmospheric air has been studied on the basis of this mechanism. The mechanism is of fundamental importance in understanding the nature of radon daughter products in the air under different environmental conditions. (auth)

6081 RADON-DAUGHTER IONS AND THEIR RELATION TO SOME ELECTRICAL PROPERTIES OF THE ATMOSPHERE. Wilkening, M. H.; Kawano, M.; Lane, Carlton (New Mexico Inst. of Mining and Tech., Socorro). Tellus, 18: 678-84(1966).

The mobilities and concentrations of the short-lived decay products of radon existing as positive small ions in the lower atmosphere were measured and compared with corresponding values for ordinary small ions in the atmosphere. Seventy five per cent of the radon-daughter ions with mobilities greater than 0.06 cm^2 sec^{-1} volt^{-1} were found in the range of 0.25 to 1.50 cm^2 sec^{-1} volt^{-1}. Ion characteristic curves gave no evidence for distinct mobility groups within the resolution available. Radon-daughter ions on the average were present in the ratio of 3 parts per 100,000 of ordinary small ions in the atmosphere. A good correlation between radon-daughter ion concentration and total small-ion content was found over a range of 100 to 1200 small ions cm^{-3}. Radon-daughter ions were found to disappear almost completely at ground level under an active thunderstorm due to upward migration of the ions under the influence of strong electric fields. The importance of radon-daughter ions in the study of the electric environment of thunderstorms was indicated. (auth)

6082 RADIOISOTOPES AS AIR MASS INDICATORS. Mueh, Helmut; Sittkus, Albert; Albrecht, Gertraud; Hartwig, Sylvius (Max-Planck-Institut fuer Kernphysik, Aussenstelle Freiburg-Schauinsland, Ger.). Z. Naturforsch., 21a: 1123-7(July 1966). (In German).

From the observation of the ^7Be, ^{32}P, ^{33}P, and ^{35}S isotopes produced by cosmic radiation, conclusions on the fate of an air mass can be made. Measurements of the absolute concentration and the isotopic ratios in rain water samples in the year 1965 showed that the insertion of stratospheric air into the troposphere can be detected in individual cases. The determinations of the ^{33}P content indicates that the yield factor used in the literature is about 25% too small. (tr-auth)

6083 DIRECT MEASUREMENT OF NATURAL AND ARTIFICIAL RADIOACTIVITY IN ATMOSPHERIC AIR. Stockburger, Helmut; Sittkus, Albert (Max-Planck-Institut fuer Kernphysik, Aussenstelle Freilburg-Schauinsland, Ger.). Z. Naturforsch., 21a: 1128-32(July 1966). (In German).

The radioactive aerosols of the atmospheric air were separated by the filter method. During the forcing through by suction, the total β radiation, the α radiation of RaA and RaC'' and that of ThC' were measured separately. The constant α/β ratio of the decay rates of the natural emitters was used in order to determine directly the β activity caused by fission products. (tr-auth)

6084 ^{28}Mg IN RAIN: PRODUCED BY COSMIC RAYS. Husain, L.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Contract AT(40-1)-2529. Science, 154: 1180-1(Dec. 2, 1966). (ORO-2529-5).

Existence of magnesium-28 produced by cosmic rays in rain at concentrations of 1.7 and 6.1×10^{-1} atoms per milliliter was established radiochemically by isolating this nuclide from several hundred liters of rain samples collected at Fayetteville, Arkansas. (auth)

6085 MODEL FOR DIFFUSION OF RADIOACTIVE DEBRIS IN THE TROPOSPHERE. Kao, S.-K. (Univ. of Utah, Salt Lake City). J. Atmos. Sci., 23: 720-5(Nov. 1966).

A theoretical model is constructed and tested for the analysis and prediction of radioactive concentration in the troposphere. It is found that turbulent motion near the jet core plays the major role in the transport of radioactive debris from the stratosphere into the troposphere, whereas the mean motion of the jet core contributes to the spring maximum and autumn minimum of the concentration. A semiannual period in the variation of concentration exists, resulting from the interaction between the meridional gradient of the mean concentration and the mean motion of the jet core. It is also found that the average value of the vertical component of the eddy diffusivity in the troposphere is about 10^7 cm^2 sec^{-1}, and that the time required for diffusing radioactive particles from the tropopause level to the surface of the earth is about 11 hours. (auth)

Mineralogy

6086 ASSOCIATION OF PITCHBLENDE WITH HALLOYSITE. Tananaeva, G. A.; Frolova, K. E. (Inst. of Economic Geology, Petrology, Mineralogy, and Geochemistry, Academy of Sciences, USSR). Dokl., Earth Sci. Sect. (Engl. Transl.), 166: 131-3(Jan.-Feb. 1966).

In certain samples in which pitchblende had crystallized at the edges, with the central part filled by a dense clay mineral of a yellowish and, less commonly, white color, detailed study showed this mineral to be halloysite. Polished sections also disclosed the disulfides of iron (pyrite and marcasite) and wurtzite as well as fine disseminations, stringers, and irregular masses of fluorite in the halloysite. The iron disulfides had crystallized as small nodules at the bottom of pitchblende crusts, while wurtzite formed nodular, thinly zoned aggregates in pitchblende and also overgrew it. Etching with weak solutions of HNO_3 or $FeCl_3$ disclosed the presence in pitchblende of inclusions of particles with the tubular shape typical of halloysite. The halloysite tubes were diversely oriented: longitudinal sections of them were also accompanied by traverse and oblique ones. Thinly zoned nodules of wurtzite with pitchblende and halloysite inclusions were seen. The pitchblende nodules situated nearer the edges of the stringer contained fewer halloysite inclusions than those nearer the center. Such relations imply that the pitchblende nodules had crystallized in a mass of halloysite and captured particles of the latter. This is the first

description of an association of pitchblende and halloysite. It appears to be representative of a specific mode of origin of pitchblende differing from that of most hydrothermal uranium deposits, where the principal gangue minerals are calcite, sericite, chlorite, quartz, adularia, and albite. The association of pitchblende with this mineral suggests that uraniferous solutions were alkaline, and that U was transported as the carbonate. The absence of minerals formed in an alkaline medium and the presence in the association of halloysite and fluorite indicate that pitchblende precipitated from relatively more acid solutions. Fluorine appears to be implicated in the transfer of U and other elements. (BBB)

6087 MINERAL EXPLORATION BY IN SITU NEUTRON ACTIVATION. Senftle, Frank E. (Geological Survey, Washington, D. C.). Trans. Amer. Nucl. Soc., 9: 593-4(Oct.–Nov. 1966).

6088 APPLICATION OF NEUTRON ACTIVATION ANALYSIS FOR THE INVESTIGATION OF ROCKS OF MANGANESE CONTENT. Beress, M. Geofiz. Kozlem., 15: 181-94(1966). (In Hungarian).

By the use of neutron activation analysis, a new method was created for the simultaneous nondestructive determination of manganese, aluminum, and silicon content in samples of rocks with an accuracy meeting industrial requirements. In the portable activation system, powdered samples of rocks of 38 g weight were simultaneously irradiated in fields of slow and fast neutrons for 4.6 minutes by the help of a polonium–beryllium source of neutrons having an intensity of 7 curies. The concentrations were computed from the pulse number measured in the intervals of 0.4 to 5.4 and 60 to 65 minutes after the irradiation was finished. The described method permits also a more accurate determination of manganese content, occasionally for drawing geochemical conclusions; in this instance, however, one must dispense with the analysis of aluminum and silicon content together with that of manganese since, in the case of more accurate manganese determination, it is necessary to prolong the duration of exposition that results in the domination of pulse number due to the isotope ^{56}Mn. The practical applicability of this method is demonstrated on a complete well log. (auth)

6089 THE CRYSTAL STRUCTURE OF $ThTi_2O_6$ (BRANNERITE). Ruh, R.; Wadsley, A. D. (CSIRO, Melbourne). Acta Crystallogr., 21: 974-8(Dec. 10, 1966).

$ThTi_2O_6$, synthesized at 1610°C by solid-state reaction, crystallizes in the monoclinic system, space group C2/m, with the unit-cell dimensions a = 9.822, b = 3.824, c = 7.036 Å, β = 118.84°. It contains layers formed by Ti—O octahedra sharing edges and corners in a manner reminiscent of the anatase structure, and these are joined through thorium ions in interlayer octahedral positions. There are two Th—O distances of 2.36 Å and four of 2.35 Å, but the octahedron is flattened; two more oxygen atoms further away at 2.96 Å are probably unbonded. Ti—O distances ranging from 1.83 to 2.20 Å are normal. The structure was determined by Fourier methods and refined by several three-dimensional least-squares cycles. (auth)

6090 GEOPHYSICAL WELL LOGGING IN IRON ORE EXPLORATORY DRILLINGS. Karasne, Tamas Zsuzsa. Geofiz. Kozlem., 15: 205-14(1966). (In Hungarian).

The utilization of gamma spectrometry with neutron capture in the detection of ore bodies in the area of Rudabanya iron ore deposits is reported. Results of the laboratory and downhole application of this method are presented. (auth)

Oceanography

6091 Ra, Io, Th, AND U IN SOME COASTAL SEDIMENT SAMPLES OF THE LIGURIAN SEA. Cerrai, E. (CISE, Milan); Schreiber, B.; Triulzi, C. Energ. Nucl. (Milan), 13: 680-6(Dec. 1966).

A reversed-phase chromatographic method was used in the separation of ^{226}Ra, ^{230}Th, ^{232}Th, and ^{238}U found in three coastal sediment cores from the Ligurian Sea. Alpha sources were prepared by electrolytic deposition, and all determinations were made by a spectroscopy. Values are given as grams per gram of sediment and these values are compared with samples from other seas. (F.S.)

6092 THE ISOTOPIC COMPOSITION OF STRONTIUM IN ATLANTIC OCEAN WATER. Hamilton, E. I. (Dept. of Geology and Mineralogy, Oxford). Earth Planet. Sci. Lett., 1: 435-6 (Nov. 1966).

No significant variations were observed for the isotopic composition of Sr in open ocean water. The results for Atlantic water, which are tabulated, confirmed that the ratio $^{87}Sr/^{86}Sr$ is constant for samples taken at depth and for biological species common to various depths. (P.C.H.)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 6025 and 6036.

6093 (DP–1055) RECOVERY OF ACTINIDES PRODUCED BY A NUCLEAR DETONATION IN VOLCANIC TUFF OR DESERT ALLUVIUM. Karraker, David G.; Perkins, William C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Dec. 1966. Contract AT(07-2)-01. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A chemical process was developed to recover transplutonium elements from the debris of a thermonuclear device detonated underground at the Nevada Test Site of the AEC. (auth)

6094 (ORNL-TM-1688) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, July 1–September 30, 1966. Blake, C. A. Jr.; Brown, K. B.; Crouse, D. J. (Oak Ridge National Lab., Tenn.). Nov. 9, 1966. Contract W-7405-eng-26. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Studies were continued on the possible behavior of radionuclides that would be present in a copper recovery process as a result of using nuclear explosives for breaking the ore. Changing the ferrous sulfate concentration of copper leach liquors had little effect on the amount of ^{106}Ru that contaminated the copper recovered from the liquors by cementation. Small-scale smelting tests with ^{106}Ru-contaminated cement copper showed no separation of copper from ^{106}Ru in the smelting process. However, an effective separation was obtained in converting the smelted copper to electrolytic copper. Copper was efficiently extracted from synthetic leach liquors with LIX-64 solutions in varsol or kerosene, and was stripped from the extract with 1.8M H_2SO_4. The LIX-64 concentration in varsol was measured by uv absorption and also by measuring the copper capacity of the solvent phase. In concluding the study of hypervelocity jet sampling as a means of removing a specimen after irradiation in the neutron flux of a detonation, five precisely-made copper cones containing gold targets were jetted at the Vincentown test range. In producing transplutonium elements through the use of thermonuclear devices, the thermal stability and high temperature reactions of actinide compounds are of interest. To study the thermal behavior of these materials, a combined thermobalance and differential thermal analyzer unit has been constructed in a glove box system. The unit permits simultaneous thermogravimetry and differential thermal analysis of materials in vacuum, air, or various atmospheres up to pressures slightly above atmospheric and temperatures up to 1650°C. In addition, the DTA-baffle plate assembly can be readily changed, permitting replacement of one type of thermocouple for another, thus optimizing the particular temperature range of interest. (auth)

6095 (PNE–507) PROJECT PRE-SCHOONER II. Technical Director's Summary Report. Final Report. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Dec. 1965. 129p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Project Pre-Schooner II was a chemical explosive single-charge cratering experiment conducted as a correlation detonation for the proposed Plowshare 100-kt Schooner nuclear cratering experiment. The primary purpose of this experiment was to improve the knowledge of cratering in a hard, dry rock and to provide information which can be used in the emplacement design of the Schooner event and in the assessment of the operational safety aspects of that event. Pre-Schooner II consisted of a 100-ton liquid explosive nitromethane charge emplaced in a spherical cavity at a depth of 71 ft in the rhyolitic rock formation of the Bruneau Canyon region in southwestern Idaho. As a result of a leak which developed in the cavity, there were only 85.5 tons of nitromethane in the cavity at detonation time with an energy equivalent yield of 94.6 tons. The crater produced by the detonation had an apparent crater radius of 95.2 ft and an apparent crater depth of 60.7 ft. The apparent crater volume was 24,780 yd^3, and the average lip crest height was 17.2 ft. The maximum range of missiles was 2320 ft. Results of surface motion studies indicate that a peak spall velocity of 129 ft/sec occurred at GZ at 27 msec after zero time. Results of the subsurface measurements program indicate that: the signal time of arrival measurements and peak stress measurements in the horizontal direction from the shot point were in close agreement with the SOC computer calculation predictions; the signal time of arrival and peak stress measurements in the vertical direction evidenced considerable scatter and were generally lower (for stress measurements) or occurred at a later time (for time of arrival measurements) than was predicted by the SOC calculation; a peak positive vertical acceleration of 3000 g was measured by the accelerometer located near the upper surface of the rhyolite medium approximately 10 ft below the surface of the ground; and the cavity pressure measurements, recorded over the time period that the fluid column functioned properly, agreed quite well with predicted measurements. Strong motion measurements recorded at two stations, located 2.4 and 4.7 km east of GZ, produced acceleration data which agree quite well with predictions. The observed displacements at these two stations and the velocities recorded at four other stations located east and north of GZ were higher than predicted. Maximum observed cloud dimensions were: crosswind base surge radius, 2100 ft; base surge height, 1060 ft; main cloud radius, 875 ft; and main cloud height, 1400 ft. Preliminary analysis of the close-in air blast measurements indicates that the ground-shock-induced pressures were twice those from previous cratering detonations at comparable scaled ranges. Analysis of the microbarograph measurements show that the average long-range air blast transmission factor was 0.19. Observations, results, and conclusions are preliminary and subject to change based upon detailed analyses and interpretation of data. (auth)

Facilities and Equipment

Refer also to abstracts 6166, 6774, 6810, 7141, 7168, 7169, and 7172.

6096 (AERE-R-5259(Pt.1)) A REVIEW OF THERMAL NEUTRON SCATTERING EQUIPMENT AT A.E.R.E., HARWELL. PART 1. ELASTIC SCATTERING APPARATUS. Dyer, R. F. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1966. 28p. Dep. BIS $0.90, HMSO 4s. 6d.

The main items of equipment used in neutron scattering experiments at the Harwell reactors are reviewed, and a description is given of the ancillary equipment available for use with the basic instruments. (auth)

6097 (AERE-R-5259(Pt.2)) A REVIEW OF THERMAL NEUTRON SCATTERING EQUIPMENT AT A.E.R.E., HARWELL. PART 2. INELASTIC SCATTERING APPARATUS. Dyer, R. F. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1966. 18p. Dep. BIS $0.60, HMSO 3s.

The time-of-flight and triple axis spectrometers for neutron inelastic scattering work are discussed together with cryostats, furnaces, and magnets. (auth)

6098 (LA-3517) TEE DRAWING FOR TUBULAR VACUUM SYSTEMS. Ruess, Hermann M.; Newkirk, James D.; Wilson, Norman G. (Los Alamos Scientific Lab., N. Mex.). Mar. 1966. Contract W-7405-eng-36. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Improved welded tee connections are made by drawing a die of circular cross section through an elliptical cutout in the wall of the main tube to form a smooth tee transition, and then butt-welding an extension tube to this opening. Fabrication procedures, tooling, and equipment have been developed for stainless steel tubing of from 1 to 6 in. OD with 0.065- and 0.125-inch wall thickness. The process has been successfully applied to copper, Inconel, aluminum, and type 304, 316, and 321 stainless steels. (auth)

6099 (NAA-SR-Memo-12239) EFFECTS OF WATER LEAKAGE INTO TANKS CONTAINING SODIUM. Douglas, R. E. (Atomics International, Canoga Park, Calif.). Nov. 10, 1966. Contract AT(11-1)-Gen-8. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

One method being considered for disposal of the Hallam primary system sodium is to bury the storage tanks directly in the earth without prior reaction of the sodium. A test was performed to determine the effects of ground water leakage into the tanks through pinholes or cracks created by corrosion and deterioration of the tanks over a long period of time. Test results indicate that the sodium–water reaction would take place at a self-regulating rate and no excessive internal pressure increase or explosive condition would be created in the tanks under conditions similar to those imposed for the test. (auth)

6100 PIPING LENGTHS FOR NUCLEAR FUEL REPROCESSING PLANTS. Dreissigacker, H. (Federal Ministry for Scientific Research, Ger.). Chem. Process Eng., 47: 68-9(Dec. 1966).

In estimating piping costs for nuclear fuel reprocessing plants, the most difficult part is estimating the length of in-cell piping

required. This can be done by means of a correlation derived statistically from values for the cell dimensions, amount of equipment and number of nozzles. A formula is presented which is derived from the correlation for the prediction of pipe lengths. (auth)

6101 SYSTEM DESIGN FOR NUCLEAR SHIPS. McFeron, D. E.; Shope, E. C. Trend Eng. Univ. Wash., 18: No. 4, 7-10 (Oct, 1966).

A "near-surface" ship with a hull capable of utilizing the advantages of nuclear power is described. It has a cigar-shaped hull submerged about one body diameter below the surface with a streamlined fin protruding above the surface, a wave-resistant platform and two outboard hulls. The outboard hulls provide living and work space for the crew and collision protection for the reactor which is located below the waterline and shielded completed by sea water. The platform could be used as an anti-submarine warfare platform or for high speed passenger service. The principal characteristics of the direct cycle boiling water nuclear power plant are: 440 MW(t) power; 5.3% enriched UO_2 fuel with a lifetime of about $2\frac{1}{2}$ yrs, and a maximum speed of 55 knots. (F.S.)

6102 DYNAMIC VIBRATIONS AND STRESSES IN ELASTIC CYLINDERS AND SPHERES. Cinelli, G. (Argonne National Lab., Ill.). J. Appl. Mech., 33: 825-30(Dec. 1966).

A new finite Hankel transform is used to find the transient displacement and stresses in thick elastic cylinders and spheres when the surfaces are subjected to dynamic loads for pure radial and torsional motion of an infinitely long circular cylindrical shell and radially symmetric motion of a spherical shell. The loads applied to both surfaces of the cylindrical and spherical shells are completely arbitrary functions of space (for the torsional case) and time. Employing the solutions obtained for the arbitrary loads, the spatial and temporal positions of these loads are then specialized to standard forms, such as a line load, band load, impulse, and so on, and the corresponding motion and stresses are found. (auth)

6103 THREE-DIMENSIONAL STRESS CONCENTRATION AROUND A CYLINDRICAL HOLE IN A SEMI-INFINITE ELASTIC BODY. Youngdahl, C. K. (Argonne National Lab., Ill.); Sternberg, E. Contract Nonr-220(58). J. Appl. Mech., 33: 855-65(Dec. 1966).

A three-dimensional solution is given, exact within classical elastostatics, for the stresses and deformations arising in a half-space with a semi-infinite transverse cylindrical hole, if the body—at infinite distances from its cylindrical boundary—is subjected to an arbitrary uniform plane field of stress that is parallel to the bounding plane. The solution presented is in integral form and is deduced with the aid of the Papkovich stress functions by means of an especially adapted, unconventional, integral-transform technique. Numerical results for the nonvanishing stresses along the boundary of the hole and for the normal displacement at the plane boundary, corresponding to several values of Poisson's ratio, are also included. These results exhibit in detail the three-dimensional stress boundary layer that emerges near the edges of the hole in the analogous problem for a plate of finite thickness, as the ratio of the plate thickness to the diameter of the hole grows beyond bounds. The results obtained thus illustrate the limitations inherent in the two-dimensional plane-strain treatment of the spatial plane problem; in addition, they are relevant to failure considerations and of interest in connection with experimental stress analysis. (auth)

6104 A COMPREHENSIVE PNEUMATIC-TUBE SAMPLE IRRADIATION, TRANSPORT, AND DISPENSING SYSTEM. Baron, Alexander I.; Herman, H.; Revesz, G.; Siev, A. (Israel Atomic Energy Commission, Yavne). Trans. Amer. Nucl. Soc., 9: 628-9 (Oct.–Nov. 1966).

6105 FUSIBLE METAL SEALS IN PROCESS EQUIPMENT. Miller, W. E. (Argonne National Lab., Ill.); Bernstein, G. J.; Hampson, D. C.; Malecha, R. F.; Slawecki, M. A. Trans. Amer. Nucl. Soc., 9: 626(Oct.–Nov. 1966).

6106 MAJOR REPAIR AND MODIFICATION TECHNIQUES USED ON LARGE-SCALE SEPARATION FACILITIES. Koontz, W. H.; Kane, J. F. (Isochem, Inc., Richland, Wash.). Trans. Nucl. Soc., 9: 625(Oct.–Nov. 1966).

6107 REMOTE MAINTENANCE IN A LARGE-SCALE SEPARATIONS PLANT. McIntosh, J. D.; Raab, G. J. (Isochem, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 624-5(Oct.–Nov. 1966).

6108 SEMI-REMOTELY MAINTAINED PLUTONIUM RECLAMATION FACILITY. Kesel, G. P.; Laws, R. B. (Isochem, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 624(Oct.–Nov. 1966).

6109 REMOTE MAINTENANCE SYSTEMS IN THE TRANSURANIUM PROCESSING PLANT. Bottenfield, B. F.; Hannon, F. L.; McCarter, R.; Hahs, C. A.; Peishel, F. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 623-4(Oct.–Nov. 1966).

6110 REMOTE DECONTAMINATION OF EQUIPMENT IN RADIOISOTOPES SEPARATIONS PLANT. Hill, A. J. Jr.; Hobert, R. H. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 9: 622-3(Oct.–Nov. 1966).

6111 ENGINEERING AND MAINTENANCE PROBLEMS IN A FUEL PROCESSING PILOT PLANT USING THE VOLATILITY METHOD. Nicol, R. G. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 622(Oct.–Nov. 1966).

6112 CONTACT MAINTENANCE OF RADIOACTIVE EQUIPMENT AT THE IDAHO CHEMICAL PROCESSING PLANT. Ayers, A. L.; Murray, C. L. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 9: 621(Oct.–Nov. 1966).

6113 MOBILE MANIPULATOR SYSTEMS. Homer, G. B. (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 9: 620(Oct.–Nov. 1966).

6114 THE ANL MARK-TV2: AN EXPERIMENTAL FIVE-MOTION HEAD-CONTROLLED TV SYSTEM. Goertz, Ray; Lindberg, John F.; Mingesz, Don; Potts, Charles W.; Kuehn, Donald E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 619-20(Oct.–Nov. 1966).

6115 ANL MARK-E4A ELECTRIC MASTER-SLAVE MANIPULATOR. Goertz, Ray; Grimson, John; Potts, Charles, Mingesz, Don; Forster, George (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 618-19(Oct.–Nov. 1966).

6116 MANIPULATOR MAINTENANCE PROGRAM AT OAK RIDGE NATIONAL LABORATORY. Jenness, R. G.; Dice, D. T.; Wicker, C. D. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 617(Oct.–Nov. 1966).

6117 CENTRIFUGAL AND OTHER ROTODYNAMIC PUMPS. Third Edition. Addison, Herbert. London, Chapman and Hall, 1966. 572p. $14.50. Barnes and Noble, Inc., New York.

The principles, design and construction, performance, and installation and operation of centrifugal and other rotodynamic pumps are presented. (R.C.K.)

6118 ACTIVATED CARBON FILTERS (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE-1515).

3 drawings.

Carbon filters are used to remove 99.9+% of the radioactive halogen vapor that could be released as the result of a containable accident of a water-moderated-and-cooled reactor. The filter is installed in the exhaust of the ventilation system of the reactor building. Tests show that iodine adsorption efficiency is consistently 99.9+% when exposed to air, nearly dry steam, and mixtures of steam, air, and entrained liquid water particles. (For details see TID-4100 Suppl. 38.) (F.S.)

6119 VACUUM ENCAPSULATING MACHINES (Engineering Materials). (Sandia Corp., Albuquerque, N. Mex.). (CAPE-1510).

27 drawings.

Two encapsulating machines are used in the clean room (See CAPE-923) to perform a wide variety of jobs with a minimum of setup change time and to approach automatic control as nearly as possible. The units are used in encapsulating electrical components into systems requiring maximum practicable cleanliness to obtain maximum dielectric strength employing a plastic system. The machines are used for special potting and casting operations requiring various processing requirements and various thermal and vacuum cycles which may include vacuum breakage with inert atmospheres, all of which must be performed in a clean environment. (For details see TID-4100 Suppl. 37.) (F.S.)

6120 GAS MIXING FACILITY (Engineering Materials). (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). (CAPE-1509).

1 drawing.

The high-pressure gas mixing facility can be used to prepare both binary and multicomponent gas mixtures with the minor component ranging in concentration from 5 ppM to any percent. A high-pressure pump allows mixtures to be prepared up to a volume of 220 ft^3 at a pressure of 2000 psi. Gas mixtures can be prepared for welding, radiation counters, environmental atmospheres, calibrations, and standards. (For details see TID-4100 Suppl. 38.) (F.S.)

6121 MINIATURE VACUUM HOT PRESS (Engineering Materials). (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). (CAPE–1511).

16 drawings.

The miniature vacuum hot press is used in forming quantities of radioactive materials in a glove box or manipulator cell. The press is readily disassembled and reassembled in a glove box through access ports. A water-cooled jacket allows rapid heating and cooling cycles. The press operates up to 1700°C and 4000 psi on samples of ¼ to ½ in. in dia. (For details see TID-4100 Suppl. 38.) (F.S.)

6122 BEAM DUMP (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE–1514).

6 drawings.

A device used to dissipate the large amounts of heat produced in the Stanford Linear Accelerator is described. The device, located at the "A" beam switchyard, consists of a dump vessel and a cradle to hold the vessel. The stainless steel vessel is 54½ in. OD, 54 in. ID and 227 in. long. It contains a number of Cu plates of varying thickness, 2 inlets, and an outlet. (For details see Tid-4100 Suppl. 38.) (F.S.)

6123 WAVE GUIDE VALVE (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE–1502).

47 drawings.

A waveguide vacuum valve used to conserve the vacuum in waveguide sections within which microwave power is transmitted, is described. The valve was designed to be used in the Stanford Linear Accelerator. (For details see TID-4100 Suppl. 38.) (F.S.)

6124 IMPROVEMENTS IN OR RELATING TO OXIDE RESISTOR FURNACES. Causer, Roy (to United Kingdom Atomic Energy Authority). British Patent 1,049,390. Nov. 23, 1966. Filed Dec. 19, 1963.

An oxide resistor furnace is described in which the supplementary heater required to raise the temperature of the resistor to the point at which it becomes conductive acts as a reflective thermal barrier around the furnace upon termination of its heating function. The furnace operates in an oxidizing atmosphere, and may be used as a heat source for a neutron diffractometer. (P.G.C.)

6125 IMPROVEMENTS IN OR RELATING TO CONTAINERS FOR TRANSPORTING RADIOACTIVE MATERIALS. Dixon, Frank Edward; Partridge, Albert Henry (to United Kingdom Atomic Energy Authority). British Patent 1,048,967. Nov. 23, 1966. Filed May 4, 1964.

A container which minimizes the effect of heat and accidental damage in transporting radioactive materials is described. The container consists of an inner lead vessel with a cavity 1.036 in. in dia and 2.5 in. deep with a wall thickness of 1.5 in. The lead vessel is closed by a spigoted lid. The lead vessel is hermetically enclosed within a close fitting mild steel canister with a lid rim which seals to the top when closed. The canister is thermally insulated by a number of discs and annular rings which surround and centrally locate the canister in an outer drum of 20 gauge MS steel 10 in. ID and 13½ in. high. The drum is fitted with a standard type closure lid. Drilled holes in the top provide pressure release in case of fire. Mild steel patches are soft soldered over the holes. The entire container weighs 10 lbs. The container is suitable for transporting 5 Ci of ^{192}Ir. (F.S.)

6126 RADIATION SHIELD HAVING A PLURALITY OF STRINGS ROTATABLE BETWEEN AN OPEN AND CLOSED POSITION. Abt, Clark C.; Vanderschmidt, George F. (to Dept. of Air Force). U. S. Patent 3,280,331. Oct. 18, 1966. Filed Nov. 15, 1963.

A method for obtaining optimum radiation shielding for energetic particles such as electrons, protons, and neutrons is described. A number of slats of shielding material with a thickness ~ equal to twice their width, mounted for rotation and spaced apart from each other by a distance not greater than half their thickness and ~ equal to their width is used. Slats are rotated from an open position (slats are parallel) to reduce flux density of high energy radiation to a closed position with no space between the slats to provide substantially complete absorption of low energy radiation. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 6122 and 7154.

6127 (KAPL-M-6559) THEORETICAL ANALYSIS OF FLOW-INDUCED VIBRATION OF A BLADE SUSPENDED IN A FLOW CHANNEL. Miller, D. R.; Kennison, R. G. (Knolls Atomic Power Lab., Schenectady, N. Y.). May 26, 1966. Contract W-31-109-eng-52. 54p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Theoretical analyses of two modes (translational motion and angular motion) of flow-induced vibration of a suspended blade are outlined. To enable a closed-form solution, it was assumed that there is no flow from one side of the blade to the other. The analyses show that under some conditions a self-excited vibration can occur, when the insertion of the blade into a narrow upstream section of the flow channel is less than a critical amount. The analyses also show that the flow rate must exceed a critical value for this vibration to occur. Theoretical results were in reasonable agreement with experimental observations, except for deviations attributable to flow around the edges of the blade. The latter effect makes the observed flow rate for inception of self-excited vibrations much higher than the theoretical value. (auth)

6128 (NAA-SR-Memo-12018) SODIUM COMPONENT TEST INSTALLATION FEASIBILITY STUDY REPORT: PRIMARY SODIUM PIPING DESIGN WITHOUT BELLOWS. Landler, G. (Atomics International, Canoga Park, Calif.). June 21, 1966. Contract AT(11-1)-Gen-8. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Bellows-free design of the primary sodium system in the Sodium Components Test Installation (SCTI) is feasible. An isometric layout of the primary pump suction and discharge lines, including the cold bypass, without bellows type expansion joints is given. The piping arrangement is shown and represents a feasible solution of the problem but not necessarily the optimum one. The feasibility studies performed on these piping configurations demonstrated compliance with the requirements of the American Standard Code for Pressure Piping ASA B31.1. Study of the effects of thermal expansion on the integrity of the connected equipment indicated feasibility of satisfying manufacturers' requirements. Studies related to the relocation of the primary pump demonstrated the feasibility of elimination of the separate sodium level control in the pump barrel and the sodium expansion tank. This study established some of the major modifications required for this alternate design but complete evaluation of this design to arrive at an adequate solution of the sodium level control problems requires additional studies. (auth)

6129 (NAA-SR-Memo-12129) SCTI: TRANSIENT THERMAL STRESS ANALYSIS OF ALCO IHX WHEN USED WITH B AND W STEAM GENERATOR. Anderson, T. L. (Atomics International, Canoga Park, Calif.). Sept. 19, 1966. Contract AT(11-1)-Gen-8. 31p. DTIE.

The Sodium Components Test Installation intermediate heat exchanger (IHX) was originally designed for service with a steam generator where the maximum temperature variation of the sodium in the IHX during thermal transients was assumed to be a linear change of 400°F in 40 seconds. With the proposed steam generator, a 490°F temperature change is possible. For this analysis, the actual response of the system to the transient was used rather than an arbitrary linear time period such as the 40 seconds. Temperature variations vs. time were calculated by the TAP computer code to permit calculation of the maximum thermal stresses during a transient. The pressure, steady state and minor transient thermal stresses previously calculated were considered still applicable. However, the manual solutions of the equations of compatibility were superseded by the modified AVCO shell program, an IBM 7090 routine. (auth)

6130 (NASA-CR-625) STEADY-STATE AND DYNAMIC OPERATING CHARACTERISTICS OF A SIMULATED THREE-LOOP SPACE RANKINE-CYCLE POWERPLANT. Hooper, J. R. (United Aircraft Corp., East Hartford, Conn.). Nov. 1966. Contract NAS 3-2335. 140p. CFSTI $3.00 cy, $0.65 mn.

Experimental investigations were conducted with a facility which simulated heat transfer and fluid flow in a Rankine-cycle space power-conversion system of the SNAP-8 type. Water was used as the working fluid. Steady-state condenser and boiler data are presented in a form suitable to a linearized analysis of the interactions of these components with the rest of the system. Frequency response data were obtained by varying the power-loop flow rate at the boiler inlet. Experimental stability maps are presented as a function of the pressure-flow slope imposed at the boiler inlet. (auth)

6131 (SAN-1013(Vol.1)) TRANSIENT BOILING PHENOMENA. VOLUME I. Final Report. Report No. NE-66-2. Schrock, V. E.; Johnson, H. A.; Gopalakrishnan, A.; Lavezzo, K. E.; Cho, S. M. (California Univ., Berkeley. Coll. of Engineering). May 1966. Contract AT(11-1)-34. 217p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A summary is presented of research performed as part of Reactor Heat Transients Project. The program had as a broad objective the development of sufficient understanding of the various

aspects of boiling in transiently heated systems to permit analysis of water reactor excursions. The research has included both experimental and theoretical approaches. In the experimental program, heat transfer and void were measured on a surface simulating a nuclear reactor fuel element. The power supplied electrically to the heating surface was increased exponentially with time to simulate a reactor excursion. All the experiments were performed with the transient initiated from an isothermal system state. Both pool (stationary liquid) and flow channel configurations were employed. A set of nominal values of the important parameters was chosen for the basic test program covering the range of pressure from ambient to 2000 psia, flow velocity from 0 to 14 fps, exponential period from 5 to 50 milliseconds, and initial liquid subcooling ranging from 0 to 112°F. A number of auxiliary experiments were performed to supplement the basic transient test program; these experiments were done to provide basic information pertinent to analytic studies and to fully characterize the equipment used in the basic test program. Analytical studies of the problem were conducted in three distinct areas: (a) transient non-boiling heat transfer to stationary and flowing liquid, (b) nucleation on a heated surface, and (c) void growth. These analyses are successful in adding insight and, with the experimental data, provide some basis for design calculations. The complexity of the problem is so great, however, that very detailed and accurate predictions are not yet possible for all aspects of the problem, particularly the void. (auth)

6132 (SU-247-8) FINITE-DIFFERENCE SOLUTION FOR LAMINAR FLOW OF GAS IN A TUBE AT HIGH HEATING RATE. Worsoee-Schmidt, P. M. (Stanford Univ., Calif. Nuclear Technology Lab.). Nov. 1964. Contract AT(04-3)-247. 140p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An implicit finite-difference scheme was developed for solving the problem of laminar flow of gases in heated (or cooled) circular tubes with an unheated entrance section, under conditions where large variations of gas properties occur. The solution is based on the boundary layer equations, the validity of which for the present problem has been verified from the numerical solutions. Numerical examples are given for air including pure forced convection with different rates of uniform heating; pure forced convection with uniform wall temperature with heating as well as cooling of the gas; and superimposed forced and natural convection with uniform heat flux. Appreciable variations of gas properties are found to be limited to the usual thermal entrance region. The concept of fully developed flow with large variations of properties upon which previous solutions have been based is not realistic. The effect of large variation of gas properties on the Nusselt number, based on properties at the mixed mean temperature, is shown to be rather modest, in agreement with the results of previous experimental investigations. The friction factor increases considerably with the heating rate, however less than indicated by some experiments. The effect of superimposed natural convection on the Nusselt number and the friction factor shows the same trend as the effect of high heating rates. The limit below which natural convection effects may be neglected has been established and is found to agree with the result for fully developed flow with constant properties. A single example computed with uniform velocity at the entrance indicates that a considerable refinement of the mesh is needed for satisfactory convergence of the finite-difference solution unless an analytical starting solution is employed. (auth)

6133 (WCAP-2056(Add.1)) HIGH TEMPERATURE SUPERCRITICAL PRESSURE WATER LOOP. DNB TESTS. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Sept. 1966. Contract AT(30-1)-2948. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A comparison of the departure from nucleate boiling (DNB) heat fluxes, measured on the SCOTT-R loop and Loop B, was made by the Thermal and Hydraulic Section of the PWR Plant Division, Westinghouse Atomic Power Divisions. Where a direct comparison between runs made in both loops was possible, an increased flow rate of 25% was required through the SCOTT-R loop to obtain comparable values of DNB heat flux, at the same pressure and inlet temperature, as on Loop B. (auth)

6134 (ANL-Trans-390) BOILING OF LIQUID ALKALI METALS. Grass, G.; Kottowski, H.; Warnsing, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Report. 37p. Dep. mn. JCL $3.60 fs, $1.31 mf.

Boiling of liquid metals at low pressures is of an unstable nature under stagnant conditions as well as under conditions of natural and forced convection. This unstable type of boiling may be interpreted as an ejection sequence of single bubbles. The kinetics involved in this ejection process are significantly influenced by the vapor pressure in the bubble. The latter depends largely on the initial superheat of the liquid which amounted for the present experimental conditions to 85°C for circulating potassium and to 130°C for stagnant potassium. During the expansion the pressure in the vapor space rapidly sinks from a high initial value, apparently due to the fact that not sufficient vaporization occurs. Initial superheat, initial pressure, and subsequent pressure variations were for various experimental conditions compared with the kinetics of the single bubble ejections. A calculation model was set up to correlate quantitatively the phenomena. (auth)

6135 (ANL-Trans-393) DEPENDENCE OF TRANSIENT HEAT TRANSFER ON HEAT FLUX DENSITY. Kudryavtsev, E. V.; Turchin, I. A. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Inzh.-Fiz. Zh., 10: 573-6(1966). 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

Transient natural convection heat transfer at a thin Nichrome ribbon was studied. The temperature distributions at Δt = constant are presented and the relation between the heat transfer coefficient and the heat flux at the heat transfer surface is found. (auth)

6136 THEORY OF DIFFUSION TUBES. Ozisik, M. Necati (North Carolina State Coll., Raleigh); Neill, F. H. Trans. Amer. Nucl. Soc., 9: 383-5(Oct.-Nov. 1966).

6137 CALCULATING VAPOR GROWTH IN A SUPERHEATED LIQUID METAL WITHIN A HEATED CHANNEL. Meinhardt, W. G. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 9: 566-7(Oct.-Nov. 1966).

6138 ENHANCED HEAT-TRANSFER TUBES FOR HORIZONTAL CONDENSERS WITH POSSIBLE APPLICATIONS IN NUCLEAR POWER PLANT DESIGN. Lawson, C. G.; Kedl, R. J.; McDonald, R. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 565-6(Oct.-Nov. 1966).

6139 EFFECT OF LOCAL FLUX PEAKS ON THE CRITICAL HEAT FLUX IN ANNULAR TWO-PHASE FLOW. Todreas, N. E. (Catholic Univ. of America, Washington, D. C. Atomic Energy Commission, Germantown, Md.). Trans. Amer. Nucl. Soc., 9: 563-5(Oct.-Nov. 1966).

6140 EXTENSION OF THE METHOD OF EFFECTIVE HOT-CHANNEL FACTORS. Gueron, Henri M.; Fenech, Henri (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 9: 563(Oct.-Nov. 1966).

6141 THE THERMAL CONDUCTIVITY OF SPHERICAL METAL POWDERS INCLUDING THE EFFECT OF AN OXIDE COATING. Swift, David L. (Argonne National Lab., Ill.). Int. J. Heat Mass Transfer, 9: 1061-74(Oct. 1966).

The effective thermal conductivity of a number of spherical metal powder-gas systems has been measured using a transient line source method. Variation of effective thermal conductivity with changes in gas pressure, temperature, and particle size was determined and the results compared with previous experiments. Uranium and zirconium powders were oxidized, and it was found that the effective thermal conductivity at atmospheric pressure decreased with extent of oxidation. An expression for randomly stacked spherical powders (void fraction = 0.40) was developed using the orthorhombic stacking arrangement and assuming linear heat flow. It was tested over a four-fold range in bulk solid conductivity to bulk gas conductivity ratio and found to give reasonable agreement. The treatment was extended to the case of metal particles with oxide coatings. It was found to agree with the uranium oxidation experiments in which a sharp decrease in effective thermal conductivity was noted in the initial stages of oxidation. (auth)

6142 HEAT TRANSFER IN A CIRCULAR TUBE WHEN THE HEAT FLUX VARIES ALONG THE TUBE AXIS. Kuga, Osamu (Railway Technical Research Inst., Japan). Nippon Kikai Gakkai Rombunshu, 32: 83-7(Jan. 1966). (In Japanese).

The heat fluxes along the coolant passages of a nuclear reactor are not uniform. The location where the wall temperature becomes the highest, therefore, differs from that calculated on the basis of uniform heat fluxes. The coolant passages of a reactor are considered to be a heat transfer system; and the effectiveness ϵ is taken as a function of the NTV (number of transfer units), and ϵ is calculated for various kinds of heat fluxes. The optimal effectiveness is obtained when the heat flux decreases exponentially along the coolant passage. But physical considerations must be considered, and it is suggested that the skew-sinusoidal heat flux distribution is desirable by arranging highly-concentrated fuel elements near the inlet of the passage. Calculations were made on the wall temperature, coolant temperature, heat transfer coefficient, and Nusselt number for the skew-sinusoidal heat flux distribution as well as for the exponential and sinusoidal heat flux distributions. (NSA of Japan)

6143 PROCEEDINGS OF THE SECOND ALL-SOVIET UNION CONFERENCE ON HEAT AND MASS TRANSFER. VOLUME I.

Gazley, C. Jr.; Hartnett, J. P.; Eckert, E. R. G. (eds.). Contract AF49(638)-1700. A Report prepared for United States Air Force Project RAND. Santa Monica, Calif., The RAND Corp., 1966. 378p. (R-451-PR; CONF-640516-(Vol.1)).

Thirty three papers are presented on heat transfer and frictional resistance in liquids or gases, the physical properties of which vary appreciably with temperature and pressure; heat transfer and frictional resistance in pipes and channels of different shapes; heat transfer and resistance studies in entry sections of pipes and channels; increasing the rate of convective heat transfer; and unsteady-state convective heat transfer. (F.S.)

Isotope Technology

Refer also to abstracts 5770, 5989, 6193, and 6316.

6144 (IA-1082, pp 255-88) APPLICATIONS. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

The use of radioisotopes and Soreq's large ^{60}Co radiation source for application in both industry and agriculture is reviewed. Authorization to use radiation for sprouting control of potatoes and onions and for insect eradication in wheat was requested. Radioisotopes are being used in tracer studies of sand movement on the sea bed, movement of silt in dry watercourses, mixing conditions in pulp chests in paper mills, corrosion mechanisms, weight distribution of carbon black in rubber, and flows from submerged springs. The effects of radiation on sugar beets, avocado pears, potatoes, strawberries, and oranges were investigated. (R.C.K.)

6145 (K-1679) THERMAL DIFFUSION COLUMN SHAPE FACTORS. PART II. SHAPE FACTORS BASED ON THE LENNARD-JONES (6-12) INTERMOLECULAR FORCE MODEL. Von Halle, E.; Hoglund, R. L. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Dec. 27, 1966. Contract W-7405-eng-26. 285p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The separation of a binary gaseous mixture, which can be obtained in thermal diffusion columns, can be calculated theoretically from the transport equation, $\tau = Hx(1-x) - (K_c + K_d)\, dx/dz$, where τ is the net transport of light component toward the top of the column, x is the mole fraction of the light component in the mixture, z is the axial column coordinate, and H, K_c, and K_d are the transport coefficients. With the aid of the tabulation of shape factors presented the transport coefficients H, K_c, and K_d can be calculated for a gaseous mixture of isotopes that obeys the Lennard-Jones (6-12) intermolecular force model. The shape factors are presented in a table, from which the transport coefficients may be calculated for concentric-tube or hot-wire columns, are to be used with the radius of the cold wall, r_1, and with the physical properties of the process gas evaluated at the temperature T_1, the temperature of the cold wall. These shape factors are defined in the manner originally proposed by Jones and Furry for hot-wire thermal diffusion columns and may be compared directly with the shape factors reported in the literature by other investigators. The shape factors presented in another table, from which the transport coefficients may be calculated for flat-plate columns, are to be used with the plate width and spacing, using physical properties of the process gas evaluated at the arithmetic average of the hot and cold wall temperatures. The shape factors reported are based on an assumed Lennard-Jones (6-12) intermolecular force model and are tabulated as a function of the reduced temperature $T_1^* \equiv T_1\kappa/\epsilon$, where ϵ/κ is a characteristic reduced energy of interaction between the molecules of the gas, the ratio of the temperature of the hot wall to that of the cold wall, and, in the case of the first table, the ratio of the radius of the outer wall to that of the inner wall. The ranges of T_1^* from 0.8 to 40.0, of the radius ratio from 1.0 to 100.0, and of the temperature ratio from 1.50 to 10.0 are included. (auth)

6146 (K-1688) THE SEPARATION OF POTASSIUM ISOTOPES BY MOLECULAR DISTILLATION. II. CASCADE PROTOTYPE TRAY. McGill, R. M. (ed.) (Oak Ridge Gaseous Diffusion Plant, Tenn.). Dec. 8, 1966. Contract W-7405-eng-26. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Experimental tests of the separative performance of the 15-stage cascade prototype tray verified that the revised design features incorporated were functional. Tests were carried out on the prototype tray alone at total reflux at three evaporating temperatures, at total reflux while interconnected to the experimental 10-stage Modex unit, and under feed and withdrawal conditions in the latter configuration. The separative performance in each case was in excellent agreement with that predicted from the Modex optimization data. (auth)

6147 (NYO-3634-3) VACUUM FOIL-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS. Quarterly Progress Report, August-October 1966. (Thermo Electron Engineering Corp., Waltham, Mass.). Nov. 30, 1966. Contract AT(30-1)-3634. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on the development of high temperature thermal insulation covering the period August through October 1966. The results of planar heat transfer tests are presented for Ta-ThO_2 insulation samples. Temperature profiles and effective heat transfer coefficients are established from the experimental heat transfer data. Results of the compatibility screening tests are summarized for exposures up to 2000 hours at 1700°C and 1900°C. Final Designs are presented for a support insulation heat loss test assembly and an extended soak test assembly. (auth)

6148 (STL-517-0034(Vol.1)) RADIOISOTOPE APPLICATIONS IN SPACE PROGRAM (POODLE). VOLUME I. THRUSTER AND CAPSULE TECHNOLOGY. Final Report, Phase A. (TRW Systems, Redondo Beach, Calif.). Oct. 1965. Contract AT-(04-3)-517. 121p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Component research and testing in the Radioisotope Applications in Space Program was summarized. Work on capsules, thrusters, nozzles, and aerospace safety is discussed. Exploratory creep and impact tests were conducted with pressurized capsules. The search for a capsule system exhibiting sufficient resistance to chemical attack focussed on refractory metal alloy substrates with noble metal alloy claddings. Graphite heaters for isotope source simulation were designed and tested. Multiple thermal shields for insulation were tested. An electrically heated thruster with flowing hydrogen was tested in a 72 hr run at operational temperatures. Spin behavior and terminal velocity of finned thrusters were studied in subsonic tests. Nozzle performance measurements were completed for a number of divergent angles, area ratios, and throat Reynolds numbers. Research on the use of polonium fuels along with recommendations for further fuel research was discussed. (F.S.)

6149 (STL-517-0034(Vol.2)) RADIOISOTOPE APPLICATIONS IN SPACE PROGRAM (POODLE). VOLUME II. PROPULSION SUBSYSTEM. Final Report, Phase A. (TRW Systems, Redondo Beach, Calif.). Oct. 1965. Contract AT(04-3)-517. 84p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Poodle propulsion system consists of propellant tankage, feed system and the thrusters. The analysis of the propellant feed system is described. Emphasis is placed on methods for obtaining single phase hydrogen by positioning devices or regenerative feed systems, and on the effects of feed system perturbations on overall performance. A computer program was developed for quasi-steady-state analyses and results obtained using it are given. Results of a survey of feed system sensor control component requirements are discussed. (F.S.)

6150 WORKING METHODS AND EQUIPMENT FOR ISOTOPE RESEARCH. Wuchatsch, Hans (Forschungsinstitut fuer Impfstoffe, Dessau, Ger.). Arch. Exp. Veterinaermed., 19: 361-5(Apr. 1965). (In German).

Most elements of the periodic system consist of a mixture of several stable isotopes. The theory of isotopic dilution and the factors, such as the isotopic composition and measurement limits that are fundamental to use of the technique are outlined. The limits of measurement, sensitivity, and methods of detection are discussed. The specialized methods of detection required for the isotopic dilution procedure are itemized. These include the use of the mass spectrometer for many stable isotopes, as well as the falling drop method, and the quartz spectrograph. The detection and measurement of radioisotopes which usually require less stringent chemical procedures and can be performed with appropriate electronic equipment are described briefly. The limits of detection of radioisotopes can be estimated to be $\sim 10^{-16}$ g or less, with dilutions of 10^9:1 being detectable. Dilutions of $\sim 10^4$:1 are detectable in some studies where ^2H is used. The factors that determine choice of the appropriate radioisotope to be used, such as chemical behavior and half life are discussed. Out of ~1000 different radioisotopes that are available, only a relatively few are suitable for biological studies. (BBB)

6151 SEPARATION OF ISOTOPES BY THERMODIFFUSION. Varga-Manyi, P. (Medical Univ., Pecs, Hung.). Acta Biochim. Biophys., Acad. Sci. Hung., 1: 197-202(1966).

A three-walled glass vessel having a center tube with a reserve volume being formed on the lower and upper sides of the tube was used in an experiment to separate isotopes by thermodiffusion. A narrow slit of the thermodiffusion tube was filled with the solution to be investigated, that is, with ^{42}KCl, or 0.1M KCl and $CaCl_2$ solution labeled with $^{45}CaCl_2$. The temperature gradient at the two sides of the slit was established by continuously heating the inner side of the tube with steam and cooling the outer side with running tap water. To ensure the constant boiling of the distilled water, heaters of about 200 w capacity were used. The results showed that ^{42}K and ^{45}Ca could be separated in a liquid system by the aid

of thermodiffusion. The efficiency of the separation was determined by the separation factor (q) which is given by the ratio of the values of the activity and sp act. of the samples taken from the lower and upper reserve volumes of the thermodiffusion tube. In most of the experiments q > 1. When the experiments were evaluated by the t test, the value P = 0.05 for the separation for K and Ca isotopes was significant. (BBB)

6152 HIGH-VOLTAGE GAMMA-ELECTRIC-CELL OPERATION. Sampson, H. T.; Miley, G. H. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc., 9: 337-8(Oct.–Nov. 1966).

6153 OPERATIONAL EXPERIENCE AT THE QUEHANNA, PA. FACILITY: A 2-MCi ^{90}Sr CONVERSION AND ENCAPSULATION PLANT. Gaitanis, Michael J.; Tripp, Lacy F. (Martin Co., Clearfield, Pa.). Trans. Amer. Nucl. Soc., 9: 611-12(Oct.–Nov. 1966).

6154 USE OF DIRECT EXCITATION BY A BETA SPECTRUM IN ISOTOPIC X-RAY FLUORESCENT ANALYSIS. Martin, Troy C.; Blake, Kenneth R.; Morgan, Ira Lon (Texas Nuclear Corp., Austin). Trans. Amer. Nucl. Soc., 9: 597-8(Oct.–Nov. 1966).

6155 USE OF TRACERS IN IN-PLANT EVALUATION OF PROCESSES AND IN POLLUTION CONTROL OF EFFLUENT FROM PAPER AND PULP MILLS INTO RIVERS. Chatters, R. M.; Peterson, R. L. (Washington State Univ., Pullman). Trans. Amer. Nucl. Soc., 9: 594(Oct.–Nov. 1966).

6156 DEVELOPMENT OF A LOW-LEVEL RADIOACTIVE-GAS TRACER SYSTEM FOR NATURAL-GAS INDUSTRIAL OPERATIONS. Armstrong, F. E. (Bureau of Mines, Bartlesville, Okla.). Trans. Amer. Nucl. Soc., 9: 594-5(Oct.–Nov. 1966).

6157 RADIO-RELEASE DISSOLVED-OXYGEN ANALYZER FOR OCEANOGRAPHIC USE. Gillespie, Arthur S. Jr.; Roberts, Kenneth F. (Research Triangle Inst., Durham, N. C.). Trans. Amer. Nucl. Soc., 9: 595-6(Oct.–Nov. 1966).

6158 STIMULATED GAMMA RAY EMISSION. Vali, Victor; Vali, Walter (to The Boeing Co.). U. S. Patent 3,281,600. Oct. 25, 1966. Filed Dec. 26, 1963.

An invention is described which relates to selectively controllable gamma ray stimulated emission devices (GASERS) and to principles and techniques for effectively producing and controlling high intensity, coherent electromagnetic radiation in the gamma spectrum by controlled change in the physical state of metastable nuclei. It provides a technique for acceleration of the decay rate, i.e., reduction of half life of metastable nuclei. (B.G.D.)

Materials Testing

Refer also to abstracts 6317 and 6364.

6159 (AD-639160) ON THE METHOD OF TESTING METALS AT HIGH TEMPERATURE AND PRESSURE VALUES. Horb, M. L. Translated from Prykl. Mekh., 10: 547-51(1964). 10p. (FTD-TT-65-1887). CFSTI $3.00 cy, $0.65 mn.

The construction of a new variant of a conical-cylindrical high-pressure chamber is described, in which the weakest detail of the cylindrical points is exposed: the cylindrical punch, which is reinforced by the chamber itself without additional supporting rings. A method is proposed for measuring temperatures in the high-pressure chamber, based on the principle of a natural thermocouple. (tr-auth)

6160 (ORO-3415-1) INDUSTRIAL EVALUATION OF RADIATION PROCESSED WOOD-PLASTIC COMPOSITES. Roberts, P. J.; Bridges, W. L.; Burford, A. O. (Lockheed Nuclear Products, Marietta, Ga.). Oct. 1966. Contract AT(40-1)-3415. 133p. (ER-8621). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Evaluations made by 68 companies of radiation processed wood–plastic composites (WPC) in a variety of end product applications confirmed the potential for use of WPC in a number of products. Additional process development and product fabrication experience is needed prior to commercial use. Machining characteristics were good but techniques had to be altered. Fastening was achieved with screws or adhesives but special bonding techniques were necessary with certain adhesives. Additional development work is needed in the production of high-quality veneers and the elimination of density variations. The estimated price of WPC was not shown to be a deterrent to WPC use. (F.S.)

6161 (SC-RR-65-298) A COMPUTER PROGRAM, SRATE, FOR THE STUDY OF STRAIN-RATE SENSITIVE STRESS WAVE PROPAGATION. PART I. Butcher, B. M. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1966. Contract AT(29-1)-789. 54p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A computer program, SRATE, that can be used to study one-dimensional stress wave propagation in certain strain-rate sensitive materials is described. Problems are limited to stress levels for which the bulk modulus of the material can be assumed constant and the plastic strain rate is a function of stress and strain. Examples of several calculations are given. (auth)

6162 SURFACE AREA AND ROUGHNESS MEASUREMENT APPLICATIONS. Kivel, Joseph (Atlantic Research Corp., Alexandria, Va.). Trans. Amer. Nucl. Soc., 9: 593(Oct.–Nov. 1966).

Protective Structures

6163 (KAPL-M-6446(Rev.1)) DESIGN OF BARRICADES FOR HAZARDOUS PRESSURE SYSTEMS. Moore, C. V. (Knolls Atomic Power Lab., Schenectady, N. Y.). July 28, 1966. Contract W-31-109-eng-52. 56p. (CVM-24). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Procedures are given for the rational design of barricades for hazardous pressure systems. Methods are given for estimating the initial velocities of missiles produced by exploding pressure vessels, and for determining the penetrating effects of these missiles on materials normally used for barricade construction. Methods are also given for estimating effective blast pressures produced by the explosion of pressure vessels. Charts and diagrams to assist in performance of the calculations are included. Some checks of the design methods against experimental data are presented. (auth)

Radioactive Material Handling

Refer also to abstracts 6099, 6125, 6775, 6861, 6862, 6863, 7885, and 7931.

6164 (BNWL-251) EFFLUENT MONITORING AND EVALUATION: A POWER REACTOR DESIGN GUIDE. Roberts, I. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1966. Contract AT(45-1)-1830. 78p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Basic information of effluent and environmental monitoring requirements of power reactors during normal operation is presented. Equipment and procedures for monitoring liquid wastes, tank, pipeline, and gaseous wastes are described. Regulations which have been issued by regulatory authorities are presented and explained. (F.S.)

6165 (BNWL-270) PRELIMINARY STUDY OF CESIUM SORPTION FROM ACID WASTE SOLUTIONS UTILIZING PHOSPHATE EXCHANGERS. Jones, Yvonne M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1966. Contract AT(45-1)-1830. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Laboratory studies are reported on the recovery of cesium from acid waste solutions by cation exchangers. Capacities, capabilities, and relative selectivities were evaluated. Equilibrium cesium capacities in the presence of competing ions were determined. Cesium column capacities as a function of acid and cesium concentrations were studied. Elution studies were made using various eluting agents; thermal effects were also investigated. A hot cell run using Purex acid waste indicated fast and efficient cesium removal by cation exchanger. (F.S.)

6166 (IA-1082, pp 311-18) MECHANICAL ENGINEERING. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

Work was carried out during 1965 on the design and installation of the industrial gamma irradiation facility and the liquid waste disposal system. (R.C.K.)

6167 (IDO-12040(Suppl.1)) RADIOACTIVE WASTE DISPOSAL DATA FOR THE NATIONAL REACTOR TESTING STATION, IDAHO. Osloond, Joe H.; Schmalz, Bruce L. (Idaho Operations Office (AEC), Idaho Falls, Health and Safety Div.). Aug. 1966. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Information is presented as to the quantities, classification, and disposition of radioactive waste accumulated during the calendar year, 1965. The information supplements a previous report issued in April 1965 which includes the 10-year period, 1955 to 1964, inclusive. (auth)

6168 (TRG-Report-1287) ESTIMATION OF THE ACTIVITY CONTENT IN CURIES OF RADIOACTIVE MATERIALS FOR TRANSPORT PURPOSES. Shaw, A. E. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). July 22, 1966. 37p. Dep. BIS $1.10. HMSO 5s. 6d.

The problems that arise when it is required to estimate the curie

content of radioactive materials to be transported under the auspices of regulations such as have been put forward by the International Atomic Energy Agency are reviewed. Estimations by calculation and from external radiation measurements are discussed, and some of the practical uncertainties that arise in each case are explored. The general conclusion is that the estimate of curie content is not very precise. (auth)

6169 (Y-KC-85) PROTECTIVE FEATURES OF A FACILITY FOR LARGE ^{235}U CASTINGS. Mee, W. T.; Crume, E. C. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Nov. 1966. Contract W-7405-eng-26. 20p. (CONF-661206-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Nuclear Society, National Topical Meeting, Nuclear Criticality Safety, Las Vegas, Nev.

The casting of fully enriched uranium in standard vacuum induction furnaces is discussed. Limits on the allowable casting charges are reviewed which are considered adequate to ensure the safety of operating personnel. The limits were based on the analyses of certain abnormal conditions that might be assumed to occur inside the furnaces. Modifications in standard equipment that can be made to allow the mass limits to be safely increased have been suggested. These mass limits are: water-cooled-coil furnace—20 kg, air-cooled-coil furnace—28 kg, air-cooled-coil furnace with neutron sources and shielding—> 28 kg. The conditions that should be fulfilled to allow safe casting of a 60 kg charge are discussed. Following the same approach and similar computations, the conditions needed for larger charges can be determined. (auth)

6170 PETRUS, HOT CELL FOR ^{252}Cf. Sontag, R.; Berger, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France). Trans. Amer. Nucl. Soc., 9: 615(Oct.-Nov. 1966).

6171 CONTAINMENT OF RADIOACTIVE MATERIAL IN THE TRANSURANIUM PROCESSING PLANT. King, L. J.; Matherne, J. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 610(Oct.-Nov. 1966).

6172 HANDLING AND CONTAINMENT OF ACTIVITY IN THE BATTELLE-COLUMBUS ALPHA-GAMMA FACILITY. Martin, R. L.; Storhok, V. W.; Gates, J. E. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 9: 610-11(Oct.—Nov. 1966).

6173 REMOTE HANDLING OF UNDERGROUND SHOT DEBRIS FOR HEAVY-ELEMENT PRODUCTION. Barnes, John W.; Lindahl, John M. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 615-16(Oct.—Nov. 1966).

6174 BASIC PLAN AND SPECIAL BOX TECHNIQUES FOR THE ALPHA-BETA-GAMMA HOT LABORATORY WITHIN THE THTR PROJECT. Pott, G.; Stockschlader, F. (Postfach 365, Juelich Ger.). Trans. Amer. Nucl. Soc., 9: 609-10(Oct.—Nov. 1966).

6175 CONTAINMENT METHODS FOR ALPHA-GAMMA RADIOACTIVITY AT SAVANNAH RIVER LABORATORY CAVES. Kelsch, R. D. (E. I. duPont de Nemours, Aiken, S. C.). Trans. Amer. Nucl. Soc., 9: 609(Oct.—Nov. 1966).

6176 PHILOSOPHY OF CHEMICAL PROCESSING EQUIPMENT DESIGN AND INSTALLATION IN THE TRANSURANIUM PROCESSING PLANT. Peishel, F. L.; Burch, W. D.; Yarbro, O. O. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 627(Oct.—Nov. 1966).

6177 ANALYTICAL MODEL FOR THE DESCRIPTION OF THE REENTRY ABLATION OF LIQUID-METAL DROPLETS. Sayles, Charles W. (Atomic International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 323-4(Oct.—Nov. 1966).

Vacuum Engineering

Refer also to abstracts 6098 and 6326.

6178 POSSIBILITIES AND LIMITS OF MEASUREMENT OF VERY LOW PRESSURES. Reich, Guenter (Hochvakuum-Entwicklungsabteilung, Cologne). Z. Instrum., 74: 254-60 (1966).

The effects which limit the reading of Bayard-Alpert gages at low pressures are described as the Roentgen effect and the ion desorption effect. Systems are discussed which permit the measurement of pressures lower than 10^{-10} torr. For pressures down to ~10^{-12} torr ion gages with the modulator described by Redhead may be used. Below this pressure other systems are used which incorporate the suppressor gage of Schuemann and the Redhead extractor gage; each of these devices is briefly described. Cold cathode gages described by Penning can also be used down to about 10^{-10} torr; this type of meter is illustrated and described, with illustrations of the dependence of current on pressure and on time at the lower limit of its utility. The sensitivity of this meter is shown to decrease so that exact measurement becomes impossible. (BBB)

6179 MODULATION CHARACTERISTICS OF SEVERAL BAYARD-ALPERT TYPE GAGES. Lange, W. J.; Singleton, J. H. (Westinghouse Research Labs., Pittsburgh). J. Vac. Sci. Technol., 3: 319-23(Nov.-Dec. 1966).

Several Bayard—Alpert-type ion gages were constructed with a modulator electrode. Curves of ion collector current versus modulator potential were obtained for each gage and as a function of other electrode potentials and electron current. The most striking difference is found to occur between gages with and without grid endcaps. For gages with open end grids, the ion collector current is found to exhibit a maximum at a modulator potential 20 to 30 V below grid potential. Such a modulation characteristic provides the opportunity to utilize the modulation technique for obtaining the true ion current and spurious current without producing gross potential changes within the gage. This results in a minimum perturbation of electron orbits and reduces pressure changes due to electron desorption and subsequent adsorption on the modulator since the modulator is continuously bombarded by electrons. (auth)

6180 SORPTION OF ACTIVATED HYDROGEN ON VYCOR GLASS. Low, M. J. D.; Argano, E. S. (Rutgers, The State Univ., New Brunswick, N. J.). J. Vac. Sci. Technol., 3: 324-8 (Nov.-Dec. 1966).

A flow system incorporating Pirani gages was used to measure the sorption of hydrogen activated by an rf discharge by Vycor glass. The sorption was dependent on the pressure and the discharge intensity. A rapid, initial adsorption was followed by a slow sorption which obeyed a $t^{\frac{1}{2}}$ law but then decelerated. The kinetics of the thermal release of hydrogen from the Vycor also followed a $t^{\frac{1}{2}}$ law. The data suggest that a steady-state condition, dependent on the hydrogen—atom population in the gas phase, was established on the surface. Hydrogen diffused into the bulk, the rate being a function of the heating of the Vycor surface by hydrogen—atom recombination. Molecular hydrogen diffused to the surface when a sample was heated. (auth)

6181 LIQUID-HELIUM-COOLED TRAP FOR ULTRAHIGH VACUUM SYSTEMS. Hopkins, B. J.; Pender, K. R. (Univ. of Southampton, Eng.). J. Sci. Instrum., 44: 73-4(Jan. 1967).

An all-Pyrex liquid helium trap was designed and tested on a Venema—Bandringa-type ultrahigh vacuum system incorporating a mass spectrometer. An overall reduction in total pressure of about one order was achieved, the remaining gases being hydrogen (8 ptorr) and water vapour (4 ptorr). (auth)

6182 ULTRAHIGH VACUUM PRODUCED BY A COMBINATION OF TURBOMOLECULAR AND TITANIUM SUBLIMATION PUMPING. Outlaw, R. A. (Langley Research Center, Hampton, Va.). J. Vac. Sci. Technol., 3: 352-4(Nov.-Dec. 1966).

An ultrahigh vacuum system using a combination of turbomolecular pumping and titanium sublimation is described. The turbine pump was used initially to evacuate the chamber. After a 400°F bakeout, the chamber was isolated from the turbine pump, and the titanium filaments were sublimated. Pressure indications of 5×10^{-12} torr were repeatedly obtained, and sublimation time versus pressure curves established. (L.C.L.)

6183 COMPARISON OF THE TRIGGER DISCHARGE GAGE WITH AN IONIZATION GAGE AND A PARTIAL PRESSURE ANALYZER. Young, J. R. (General Electric Co., Schenectady, N. Y.). J. Vac. Sci. Technol., 3: 345-9(Nov.-Dec. 1966).

The trigger discharge gage has been compared with a thoroughly processed Bayard-Alpert ionization gage capable of measuring pressure to 2×10^{-11} torr. Differences no greater than a factor of two were observed between the two gages for pressures between 1×10^{-10} and 10^{-4} torr. By subtracting the x-ray limit of 2×10^{-11} torr, the ionization gage readings were corrected and indicated fair agreement with the trigger discharge gage down to 1×10^{-11} torr. Comparison of these gauges with a partial pressure analyzer indicated the ionization gage output decreased linearly down to 10^{-10} torr and saturated at 2.6×10^{-11} torr while the trigger discharge gage current varied as $P^{1.2}$ in the range between 10^{-7} torr to 5×10^{-12} torr—the lowest indicated pressure achieved while operating the partial pressure analyzer. It is concluded that slow and continued ion desorption and outgassing of the ionization gage are responsible for differences of more than a factor of two in trigger and ionization gage readings. (auth)

6184 CALIBRATION OF LOW PRESSURE PENNING DISCHARGE TYPE GAGES. Lange, W. J.; Singleton, J. H.; Erik-

sen, D. P. (Westinghouse Research Labs., Pittsburgh). J. Vac. Sci. Technol., 3: 338-44(Nov.-Dec. 1966).

Two cold cathode discharge gages were calibrated from 10^{-4} to 10^{-12} torr for argon and hydrogen and to 10^{-10} torr for helium, nitrogen, and carbon monoxide. With minor exceptions the sensitivity decreases with pressure; for example, the sensitivity for argon for one gage was ~3.5 A/torr at 10^{-4} torr, ~1.5 A/torr at 10^{-10} torr, and ~0.1 A/torr at 10^{-12} torr. The calibration may be represented by a series of linear segments which probably correspond to stable discharge modes in the gage. In addition, overlap of stable modes occurs and hence the accuracy of pressure measurement is difficult to predict even with a detailed calibration of a specific gage. (auth)

6185 RESPONSE OF THE TRIGGER DISCHARGE GAGE. Bryant, P. J.; Gosselin, C. M. (Midwest Research Inst., Kansas City, Mo.). J. Vac. Sci. Technol., 3: 350-1(Nov.-Dec. 1966).

The pressure response characteristics of the trigger discharge gage, a modified Penning cell, are described and plotted. Four trigger discharge gages (TDG) were tested in pressures from 10^{-3} torr to 10^{-12} torr. The data were checked by pressure ratio technique, direct comparison to modulated ion gages, and both direct and pressure ratio comparisons to Redhead gages. The TDG design tested showed three characteristics: the response is nonlinear with pressure; a background current accompanies ion current; and the ion current response may be lost or may fail to develop at low pressures. These results are the same as previous evaluations of Penning cell devices. (L.C.L.)

6186 CRYOSORPTION PUMPING OF HELIUM AT 4.2 DEG K. Grenier, G. E.; Stern, S. A. (Union Carbide Corp., Tonawanda, N. Y.). J. Vac. Sci. Technol., 3: 334-7(Nov.-Dec. 1966).

The cryosorption pumping of helium gas by means of Molecular Sieve 5A cryosorption panels has been studied at 4.2°K and in the pressure range from 10^{-7} to 10^{-6} torr. The sticking coefficient of the gas was found to vary from about 0.70 to 0.91 at these pressures, respectively, corresponding to the high pumping speeds of 20000 to 27000 liter/sec/ft^2 of panel. The absorptive capacity for helium was also high down to 10^{-8} torr, but the pumping speed decreased with increasing surface coverage. It is concluded that helium can be pumped effectively in the high-vacuum region with cryosorption panels refrigerated to 4.2°K. (auth)

6187 RESIDUAL GASES IN OIL AND MERCURY PUMPED SYSTEMS. Singleton, J. H. (Westinghouse Research Labs., Pittsburgh). J. Vac. Sci. Technol., 3: 354-5(Nov.-Dec. 1966).

An experiment to determine if the residual gas in an ultrahigh vacuum system is influenced by the choice of an oil or mercury diffusion pump is described. Octoil-S and DC-704, a silicone-type oil was used in the oil diffusion pump. Each pump was mounted on a single system which included a modified Bayard-Alpert ion gage and a high sensitivity mass spectrometer. The system was rebuilt for each pump installation so that ~25% of the system had not been previously processed for ultrahigh vacuum. The system was baked out and the ion gage degassed. The results do not indicate any significant difference in the hydrogen level when using the different pump fluids. Tables of experimental conditions and the results of the residual gas analysis are given. (R.C.K.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 5804, 6164, 6352, 6511, 7039, 7340, 7355, 7607, 7631, and 7771.

6188 (AD–636530) ROCKET-BORNE AURORAL X-RAY INSTRUMENTATION. Scientific Report No. 2-UU-66-4. Howlett, L. Carl (Utah Univ., Salt Lake City, Upper Air Research Lab.). Feb. 28, 1966. Contract AF 19(628)-4995. 76p. (AFCRL–66-162). CFSTI $3.00 cy, $0.65 mn.

An x-ray detector suitable for inclusion in a rocket payload for x-ray studies must be capable of measuring x-ray flux and energy spectrum between 1 and 10 A. The instrument must also be insensitive to acceleration, temperature changes, vacuum, and a flux of up to 10^8 electrons sec sq cm ster having energies from 1 to 50 keV. Three practical types of detectors suitable for rocket flight are energy selective Geiger tubes, scintillation spectrometers, and proportional counters. Geiger tubes which are made sensitive over a relatively narrow range of energies by careful selection of fill gas and window material provide outputs which are easily handled electrically but at the sacrifice of energy resolution. The proportional counter system has the best energy resolution but also the lowest level output and, therefore, requires considerable care in shielding from extraneous sources of electrical noise. Flight systems using scintillation spectrometers and proportional counters telemeter the amplified and broadened pulses directly from the detectors. (auth)

6189 (AD-641843) SILICON DIODE FAST NEUTRON DOSIMETER. PHASE I. EVALUATION OF RESPONSE VERSUS STARTING MATERIAL. Swartz, J. M.; Chase, B. H.; Thurston, O. M. (Phylatron Corp., Columbus, Ohio). Oct. 1966. Contract DA-18-035-AMC-101(A). 45p. (NDL-TR-83-I). CFSTI $3.00 cy, 10.65 mn.

The results obtained from an investigation of the effects of n- or p-type doping, resistivity, and method of crystal fabrication (pulled or float-zone) on the response of silicon-diode fast-neutron dosimeters are presented. The high-level lifetime, the reverse-recovery lifetime, and the current-voltage characteristic were measured for diodes fabricated from each type of starting material, and these parameters were then followed as the diodes were exposed to various neutron fluences. Preliminary results of isochronal annealing experiments and the effects of maintaining the diodes at low temperatures during irradiation are also presented. It was expected that the high-level damage constant, derived from the high-level lifetime, would be independent of the resistivity of the starting material, and this was demonstrated experimentally. Annealing results suggest that at least seven levels are involved in the degradation of lifetime by fast neutrons, and studies of devices irradiated at 77 and 273°K revealed an increased amount of observed damage. (auth)

6190 (BNL–9721) A SIMPLER AND FASTER MECHANICAL FLYING SPOT DIGITIZER FOR AUTOMATIC FILM ANALYSIS. Zuroff, C. A.; Hough, P. V. C. (Brookhaven National Lab., Upton, N. Y.). Nov. 19, 1965. Contract AT-30-2-GEN-16. 39p. (CONF-651044–14). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Programming for Flying Spot Devices, New York.

A new Flying Spot Digitizer (FSD) design permits 94 Mc information bandwidth and micron level accuracy in the same instrument. The instrument is simpler than previous FSD designs and is recommended for new installations. The high speed scan generator is adaptable to existing FSDs. Information bandwidth, number of resolution elements scanned per second, is about 47 times that of existing FSDs. For application to large chamber film, spot size would be halved, (doubling the number of resolution elements per unit length). Linear spot speed could be increased up to 23 times. Need for linear scan capability of up to ten times that of existing FSDs is discussed. (auth)

6191 (BRL-R–1335) STILBENE SPECTROMETER FOR NEUTRONS AND GAMMAS: ELECTRONICS AND RELATED PERFORMANCE. Frank, Konrad (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Sept. 1966. 169p.

The instrumentation package of a spectrometer system for neutrons and gamma rays is discussed in detail. The pulse signals produced in stilbene crystal by neutrons and gamma rays are stored simultaneously in different memory subgroups of a multichannel analyzer by using pulse shape discrimination techniques. Neutrons in the energy range from 0.5 to 20 MeV and gamma rays in the energy range from 0.15 to 11 MeV are analyzed with a discrimination ratio exceeding 1000:1. The lower energy discrimination limit of the system is 22 keV electron energy which corresponds to 270 keV neutron energy and 90 keV gamma ray energy. (auth)

6192 (CEA-R–3045) TABLE DE DEPOUILLEMENT BIP 101 POUR CLICHES DE CHAMBRES A BULLES. (Scanning Table BIP 101 for Bubble Chamber Pictures). Calmels, Christian (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1966. 8p. (In French). Dep. mn.

BIP 101 is a new scanning table for bubble chamber pictures, especially aimed at the full scale projection of the CERN 2m hydrogen chamber. The table itself is divided in two half tables, each of them receiving, successively or simultaneously, the projections of 2 of the 4 films. Projectors with film transport are located in the central space between both half tables. Their light is reflected on 2 mirrors fixed at the ceiling. Thus the 4 sides of the table are freely accessible to the scanners. It will be possible to equip later the table with digitizers, allowing premeasurements of the events for HPD device, or even measurements. (auth)

6193 (CEA-R–3071) CONTRIBUTION A LA MESURE PRECISE DE L'ACTIVITE DE SOURCES NON PONCTUELLES AU MOYEN DE LA CHAMBRE D'IONISATION A PUITS. (Contribution to the Precise Measurement of the Activity of Non-Point Sources by the Use of the Well-Type Ionization Chamber). Dalmazzone, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1966. 146p. (In French). Dep. mn.

Thesis.

The well-type ionization chamber is commonly used to measure the activity of solid, liquid or gaseous β, γ and $\beta-\gamma$ sources (the first by making use of Bremsstrahlung) over a wide activity range (from a few μCi to several Ci). The volume of these sources can be appreciable owing to the existence of large zones of equal sensitivity verified by means of a Ra point source. However the response of the chamber is closely dependent on the geometry of the source, in particular its volume, for weakly penetrating radiations such as β's, Bremsstrahlung and soft γ's ($E\gamma$ below 100 keV), because of the attenuating power of the materials making up the source, the measuring apparatus and the comparatively high ionizing power of low-energy x and γ rays (predominant photoelectric effect). (auth)

6194 (COO–1195-81) SCANNING AND MEASURING PROJECTOR. Downing, R. W.; Mortara, D. W.; Schaad, C. A. (Illinois Univ., Urbana). Nov. 10, 1966. Contract AT(11-1)-1195. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Scanning and Measuring Projector (SMP) is a semiautomatic device for making rapid and accurate measurements of particle interactions from photographs of these events as they occurred within a bubble chamber. The SMP and a general purpose digital computer, CSX 1, work together in an integrated system. The operator scans the film and guides a detector approximately (± 0.5 cm) along the path of the points to be measured. The points are accurately digitized by an apparatus that sweeps the selected portion of the image across a fixed pattern of reference marks. The overall layout of the SMP system is described and the SMP digitizing mechanism and process are explained. Also discussed are the pattern-recognition and time-sharing aspects of the corresponding computer program, and its error-correction capabilities. (auth)

6195 (DESY–66/25) EIN AUTOMATISCHES GERAET ZUR AUSMESSUNG VON FUNKENKAMMERBILDERN. (An Automatic Apparatus for Surveying Spark Chamber Pictures). Becker, U.; Hoehne, K.; Weber, J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sept. 1966. 26p. (In German). Dep. mn.

An automatic device for the measurement of spark chamber pictures is described. Using the flying spot technique, it measures 24 × 36 mm pictures on reversal film in 8 sec per frame. The accuracy of a single digitization in the direction parallel to the spark chamber plates is ±10 μm; in the perpendicular direction the accuracy is better than ±36 μm. It is shown that with three digitizations per spark the accuracy of the device considerably exceeds that of hand measurements. The hardware components are described and the performance of the apparatus is discussed in detail. (auth)

6196 (EGG–1183-2097) DECAY TIMES OF LIQUID SCINTILLATORS. Technical Note No. S-59-TN. Kirkbride, J.; Yates, E. A.; Crandall, D. G. (Edgerton, Germeshausen and

Grier, Inc., Santa Barbara, Calif.). June 1966. Contract AT (29-1)-1183. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Scintiallation decay profiles were measured for twenty different liquid organic scintillators, encapsulated in identical glass cells that fitted directly into a fluor-decay apparatus. An analysis of the results is presented. (B.G.D.)

6197 (IS-1449) MEASUREMENT OF THE THERMAL NEUTRON SPECTRUM FROM A NEUTRON CHOPPER. Sleege, Gary A.; Camp, Roger C. (Ames Lab., Iowa). Sept. 1, 1966. Contract W-7405-eng-82. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An electronic system is described which is a time of flight to energy converter. The flight time over a distance is the information essential to determine the kinetic energy of neutrons. A neutron chopper is used to gate the neutrons so that a starting time is known. A neutron detector is located at the end of the flight path to indicate when the neutron's flight is over. The kinetic energy is then determined by the equation $E = \frac{1}{2}m\ D^2/t^2$. A voltage that is proportional to E is generated starting when the neutron chopper opens. This voltage is sampled at the time when a neutron strikes the detector. The voltage pulse produced is proportional to the kinetic energy of the neutron. As neutrons with different kinetic energies strike the detector, a spectrum of voltage amplitudes is produced. These voltage pulses are sent to a pulse height analyzer for storage. The energy range of this system is 0.01 ev to 0.05 ev. (auth)

6198 (JINR-P13-3064) UVELICHENIE DLITEL'NOSTI RAZRYADA V ISKROVOI KAMERE DO 10-100 MSEK. (Increasing the Discharge Duration in a Spark Chamber up to 10 to 100 mu sec). Akimov, Yu. K.; Protsenko, V. N.; Rykalin, V. I.; Tyapkin, A. A.; Khromov, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 11p. (In Russian). Dep. mn.

A method to increase the discharge duration in a spark chamber for the time up to 10 to 100 μsec is described and investigation results of such discharge conduct in time are given. (auth)

6199 (JUL-411-PC) STANDARDIZATION OF ALPHA-EMITTERS BY LIQUID-SCINTILLATION COUNTING. Ihle, H. R.; Murrenhoff, A. P.; Karayannis, M. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Physikalische Chemie). Sept. 1966. 10p. (CONF-661012-46). Dep. mn.

From IAEA Symposium on the Standardization of Radionuclides, Vienna, Austria.

Internal liquid scintillation counting allows a high precision in the standardization of solutions of α-emitting nuclides. The method has a number of advantages: under appropriate experimental conditions, a 4π geometry is obtained; the difficulties with sample self-absorption and backscattering often encountered in methods necessitating mounting of the samples on plates are eliminated. One condition of particular importance for standardization is the stability of the liquid scintillation sources over long periods of time. Measurements with actinide-nuclides from thorium to curium showed that the ions of the actinides can be stabilized by means of tri-n-octyl-phosphineoxide (TOPO), which simultaneously acts as complexing agent and counteracts the quenching effects of acids. A technique for the comparison of liquid scintillation counting with other absolute counting methods, which avoids the possible sources of errors from weighing or pipetting of aliquots, was developed and verified. The method was applied to new determinations of the specific activity of ^{239}Pu and ^{233}U with an accuracy of ±0.3% and ±0.2% respectively. In the liquid scintillation counting a precision of ±0.05% was obtained. Because of the high time resolution of liquid scintillation, further improvement in precision can be expected when fast electronic systems are used. (auth)

6200 (ORNL-TM-1668) DESCRIPTION OF FACILITY RADIATION AND CONTAMINATION ALARM SYSTEMS INSTALLED IN THE HIGH RADIATION LEVEL CHEMICAL DEVELOPMENT LABORATORY 4507. Russell, J. A. Jr.; Knowles, D. J. (Oak Ridge National Lab., Tenn.). Oct. 27, 1966. Contract W-7405-eng-26. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Facility radiation and contamination alarm systems were installed in the High Radiation Level Chemical Development Laboratory to continuously and automatically monitor gamma radiation (by six gamma monitrons), neutron radiation (by three neutron rate-burst detectors), and air contamination (by five beta-gamma and three alpha constant air monitors) in the entire facility. These instruments and other components in the network provide health physics monitoring information, sound local alarms when abnormal conditions occur, and indicate the abnormal conditions on a central panel board. Operating personnel are first given warning then radiation or air-borne contamination detected by a monitron or beta-gamma air monitor, respectively, reaches a preset caution level. A second warning is given when the high-level set point is reached. The neutron detectors operate rate or burst alarms when the alarm levels are exceeded. The building is automatically "contained" when two or more monitrons, two or more beta-gamma air monitors, or any alpha air monitor detects a high level of radiation or air contamination. The building evacuation system operates automatically when two or more selected monitrons or two or more beta-gamma air monitors detect a high level of radiation or air contamination, or when two or more neutron monitors detect a neutron burst or high-rate, or when any alpha air monitor detects a high level of radioactive contamination. (auth)

6201 (RT-FI-(66)-17) SEMICONDUCTOR DETECTORS AND SMALL FISSION CHAMBERS FOR FAST NEUTRON SPECTRAL ANALYSIS. Balducci, G.; Martini, M.; Vigo, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 21p. (CONF-650832-2). Dep. mn.

From International Meeting on Nuclear Spectroscopy Instrumentation, Herceg-Novi, Yugoslavia.

In order to evaluate the hystogram of fast neutron spectrum, fission detectors were developed. Surface barrier detectors and small fission chambers were used to measure fission rates of materials with different fission thresholds. The elements used are ^{235}U, ^{233}U, ^{239}Pu, ^{237}Np, ^{238}U, and ^{232}Th. The solid state detectors are placed in a steel cal with a nickel disk on which a fissionable element was deposited by vacuum evaporation technique. The fission chambers are parallel-plate ionization types with an $A-A_2$ mixture atmosphere and very high (about 99%) efficiency for the fission products. Both counters are small enough to avoid distortion of neutron flux. The fission counters are calibrated by determining the alpha counting rate or, in a thermal neutron flux, by counting the fission fragments. The results of irradiations (all relative to ^{235}U fission) are well consistent. (auth)

6202 (SGAE-G-4/1966) THE PHYSICS OF HIGH RESOLUTION GAMMA-SPECTROSCOPY AND EXPERIMENTAL RESULTS WITH A SEMI-CONDUCTOR COMPTON-SPECTROMETER FOR NONDESTRUCTIVE BURN-UP DETERMINATION OF NUCLEAR FUEL. Higatsberger, Michael J. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). [1966]. 20p. (CONF-660938-1). Dep. mn.

From 7th Annual Symposium on Physics and Nondestructive Testing, Chicago, Ill.

Operating principles of a semiconductor Compton spectrometer are discussed. Its performance in determining the burnup history of the reactor fuels is discussed. (M.O.W.)

6203 (UCRL-13251) NUCLEAR STUDIES OF THE COMPTON DIODE, FISCAL YEAR 1966. Stevens, J.; Artuso, J. F. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Nov. 1966. Contract W-7405-eng-48. 82p. (EGG-1183-2110; S-349-R). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For California Univ., [Livermore]. Lawrence Radiation Lab.

A spherical electrostatic spectrometer was used to measure electron currents emitted from metal plates bombarded with gamma rays from ^{60}Co and ^{137}Cs sources. Measurements of the current leaving the target, as a function of the retarding field, yield energy spectra in the range of approximately 0 to 1500 eV. Theoretical energy resolution of this spectrometer is 1.7 percent. Comparisons between theory and experiment are made for both energy spectra and total yield. Calculations are also discussed of the angular and energy distributions of the high-energy electrons knocked out of the plate by the gamma rays. The present theory which calculated quantum efficiencies at 0.662 and 1.25 MeV correctly, calculates energy and angular distributions incorrectly. The expression currently being used to calculate the transmission of electrons is analyzed and shown to be somewhat in error. The need to consider Möller scattering is pointed out, and equations for determining the effect of secondary electrons on response function are presented. Some results of quantum efficiency calculations are listed and the need for experimental data at additional energies is pointed out. (auth)

6204 (UCRL-17075) PROCEDURES FOR FINDING FISSION TRACKS IN MICA AND MYLAR. Kleppe, Lowell M.; Mary Roger, R. S. M. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 25, 1966. Contract W-7405-eng-48. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A procedure is described for recording, etching, and counting the tracks of fission fragments in mica and Mylar resulting from the neutron bombardment of various heavy elements. Sensitivity comparisons as well as annealing and etching conditions for both mica and Mylar are described in detail. Tracks of fission fragments in mica and Mylar can be used to locate uranium and thorium in thin rock sections; mica and Mylar can be used with metals as threshold detectors for neutrons of different energies. (auth)

6205 (UCRL-50146) PRACTICAL APPLICATIONS OF STOCHASTIC ANALYSIS OF COUNTING RATE MEASUREMENTS. Gelinas, Robert J. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 1966. Contract W-7405-eng-48. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Some of the more latent principles of stochastic analysis are briefly reviewed in order to provide a common base of understanding and terminology for ensuing discussion and developments. Particular emphasis is devoted to a description of the quantities that are conveniently measured in actual experimental measurements. The essence of how these macroscopic observables then relate to microscopic causal mechanisms within an interacting system will be indicated in order to illustrate the ultimate power of stochastic measurements. Finally a number of stochastic experiments that may now have become quite feasible (in view of recent improvements in measuring techniques) are suggested. (B.G.D.)

6206 ELECTRONICS IN NUCLEAR MEASUREMENTS. PART I. RADIATION DETECTORS. Price, L. W. (Cambridge Univ., Eng.). Lab. Pract., 15: 1379-84(Dec. 1966).

Radiation detectors and the basic circuits used for determining the radioactivity of a sample are considered. The methods used fall into two groups: those in which the height of the detector output electrical pulse is proportional to the energy of the initiating particle, and those in which the output pulse is almost independent of the particle energy. (auth)

6207 USE OF THE MINIATURE SILICON DIODE AS A RADIATION DOSEMETER. Raju, M. R. (Univ. of California, Berkeley). Phys. Med. Biol., 11: 371-6(1966).

The use of commercially available miniature silicon diodes as dosemeters, with particular reference to their application to biomedical facilities at cyclotrons, is discussed. They are simple and convenient, and their small size makes them ideal for use as beam profile detectors. (auth)

6208 LOADING OF NUCLEAR RESEARCH EMULSIONS WITH DIAMOND CRYSTALS. Goodhead, D. T.; Ismail, A. Z. M.; Prakash, Y. (Oxford Univ.). Nucl. Instrum. Methods, 46: 157-64(1967).

The results are presented of an investigation into the loading of nuclear research emulsions with diamond crystals of diameter in the range 1–12 μ. The conclusions are applicable generally to chemically inert solids obtainable in the form of small grains which are effectively opaque or cause large optical scattering. Also this process, with modifications, is applicable to transparent grains. The experimental procedure for uniform loading of solid grains in emulsion plates or pellicles is described; and a general parameter F_1 is deduced to enable an upper limit to be set to the quantity of material of given grain size which can be loaded in emulsion of a given thickness without greatly affecting the optical clarity of the emulsions. Local distortion around the solid objects, due to the shrinkage of emulsions, is considered and a method is suggested for its elimination. The reliability of kinematical analyses of events occurring in the diamond grains is investigated. (auth)

6209 EQUIVALENT CIRCUIT FOR THE STATISTICAL BEHAVIOR OF THE SCINTILLATION COUNTER. Donati, S.; Gatti, E.; Svelto, V. (Laboratori CISE, Milan). Nucl. Instrum. Methods, 46: 165-70(1967).

An exact solution for the statistical behavior of the scintillation counter, considering time-dependent branching processes is presented. A statistical equivalent circuit was obtained for the phototube useful for determining the accuracy of energy and time measurement. (auth)

6210 CORRECTION OF RESPONSE DISTORTION OF NONLINEAR RATEMETERS. Watson, K. K.; Pilgrim, D. H. (Univ. of New South Wales, Sydney). Nucl. Instrum. Methods, 46: 145-8(1967).

Recent studies on ratemeter performance in relation to response distortion are discussed and the response equation for a particular nonlinear system detailed. Possible correction methods for determining the unknown time-dependent input from the recorded output are then briefly discussed. The finite difference solution is considered in detail and comparisons made between the true and computed inputs for two analytical input functions. (auth)

6211 LIGHT COLLECTION ON A PHOTOCATHODE FROM A CYLINDRICAL SCINTILLATOR. Cocchi, M.; Rota, A. (Joint Nuclear Research Center, Ispra, Italy). Nucl. Instrum. Methods, 46: 136-40(1967).

The influence of scintillation detector geometry on the time probability of photon collection at the photomultiplier photocathode is studied. Results are given for three different cases. The geometrical effects cannot be neglected when time resolutions of the order of a 100 psec are required. (auth)

6212 ENERGY CALIBRATION OF NEUTRON VELOCITY SPECTROMETERS. Wynchank, S. A. R. (Columbia Univ., New York). Nucl. Instrum. Methods, 46: 141-4(1967).

Aspects of energy determination in the measurement of cross sections by neutron time-of-flight are described, with particular regard to the establishment of Zero Time. The value of intercomparison of data from different laboratories is explained and indications of the presence of the different types of systematic error are outlined. Prospects for the future of neutron time-of-flight studies are described. As an example of the use of a proton accelerator which produces neutrons for time-of-flight measurements, some characteristics of the Nevis Synchrocyclotron of Columbia University and projected improvements for it are outlined. (auth)

6213 COMPARATIVE STUDY OF RESPONSE CORRECTION METHODS FOR LINEAR RATEMETERS. Pilgrim, D. H.; Watson, K. K. (Univ. of New South Wales, Sydney). Nucl. Instrum. Methods, 46: 77-85(1967).

Six methods are described for the correction of the response time distortions which occur in the outputs of linear ratemeters when measuring time-dependent systems. Such corrections are necessary for valid interpretation of the physical system under investigation. The methods have been tested by applying them to a variety of input-output sequences, using both theoretical output values calculated from analytical input functions, and also experimental outputs from ratemeters under laboratory and field conditions. A finite difference solution and an iterative method are found to be the best procedures and both give adequate accuracy under most circumstances in practice. The conditions influencing which of these two methods is better in a given situation are discussed in detail. (auth)

6214 STUDY OF WIDE GAP SPARK CHAMBERS. Aronson, S. H.; Catura, R. C.; Chen, H. H.; Chen, K. W. (Princeton Univ., N. J.). Nucl. Instrum. Methods, 46: 93-8(1967). (PPAD-590-E).

Those properties of a wide gap spark chamber which determine its utility as a momentum measuring device were investigated in a study performed at the Princeton-Pennsylvania Accelerator (PPA). In addition, measurements were made on the efficiency with which a vertex event occurring within the chamber gap can be observed. The spark chamber used in this investigation had a gap of 41 cm and each electrode was made of 0.001" aluminum foil. High efficiency for detection of single charged particles was obtained both inside and outside a magnetic field and for angles up to 30° relative to the chamber axis. The momentum resolution for charged particles was measured to be ±1.1% at 395 MeV/c in a magnetic field of 5.2 kG. The limit of this resolution was set by the method of measurement and not by performance of the spark chamber. When compared with observations in conventional narrow gap spark chambers, no inefficiency was observed for detecting vertex events originating within the wide gap chamber. (auth)

6215 PERFORMANCE OF A LARGE MAGNET SPARK CHAMBER. Astbury, P. (CERN, Geneva); Finocchiaro, G.; Michelini, A.; Websdale, D.; West, C. H.; Beusch, W.; Gobbi, B.; Pepin, M.; Polgar, E.; Pouchon, M. A. Nucl. Instrum. Methods, 46: 61-9(1967).

The description of a $60 \times 67 \times 160$ cm^3 spark chamber in a 10.5 kG magnetic field and a report on its performance are given. This instrument was used at the CERN Proton Synchrotron for the detection of the neutral (and non-π^0) reaction products of π^-, K^- and $\bar{p}$ on hydrogen. The sources of the systematic deviations in spark position were investigated and corrections were devised to compensate for them. The residual random errors are: the rms deviation of individual sparks from the fitted trajectory $\sigma_y = 0.18$ mm in space, and the rms measurement error $\sigma_{y\ meas} = 0.09$ mm in space. The MDM of the instrument is 1000 GeV/c and the rms error in the mass of K^+_1 mesons of 7 GeV/c momentum is $\Delta m = 7.3$ MeV/c^2. (auth)

6216 NEW TYPE OF NEUTRON CHOPPER FOR MEASUREMENTS WITH VERY SLOW NEUTRONS. Tunkelo, E.; Palmgren, A. (Technical Univ., Otaniemi, Finland). Nucl. Instrum. Methods, 46: 70-6(1967).

A description is given of a neutron chopper in which the neutrons when traversing the rotor move in the same direction as the surrounding material. The neutron path in the coordinate system rotating with the chopper is a closed curve, so that the neutrons enter and leave the chopper through the same opening on the periphery of the rotor. A specimen can be placed in the neutron path inside the rotor so that the relative velocity is much smaller than the velocity of the neutron. Thus transmission measurements in the μeV region (about 100 Å) are made possible. Inelastic scattering measurements of these almost zero-energy neutrons are discussed as well. The same chopping principle is utilized in another design which can be used as monochromator for 10–30 Å neutrons. Trans-

mission and resolution considerations of these devices are presented. (auth)

6217 SLICING METHOD FOR SIDE-VIEWING NUCLEAR PHENOMENA IN EMULSIONS. Fukui, K. (Air Force Cambridge Research Labs., Bedford, Mass.). Nucl. Instrum. Methods, 46: 109-15(1967).

In order to see a side view of nuclear phenomena in photographic emulsions, a new technique of slicing was developed. The emulsion is cut normal to its surface plane into slices fifty to two hundred μm thick which contain the phenomenon whose side view of interest. The slice is then mounted on a glass microscope slide restoring its original dimensions so that the phenomenon can be analyzed from the horizontal direction. This method is useful, for example, for identifying the charge of cosmic radiation particles that enter the emulsion making large dip angles with the surface plane. The method and its applications are described in detail. (auth)

6218 USE OF THE STATISTICAL FLUCTUATIONS FROM THE NEUTRON DETECTORS ANALOG SIGNALS. Plaige, Y.; Quenee, R. (CEN, Saclay, France). Onde Elec., 1173-9(Nov. 1966). (In French).

A short survey of the theory shows how it is possible to use the statistical fluctuations of ion chambers signals to measure neutron flux or other nuclear radiations. An apparatus based upon this principle is described. It is discussed on possible features, difficulties met and results (logarithmic measurement possible upon six power decades). The results of measures carried on Aquilon and Pegase reactors with this set up are given. In conclusion this device is compared with the usual device (measurement of the dc level) and the advantages of the two processes (particularly neutron-gamma discrimination) are underlined. (auth)

6219 IMPROVEMENT POSSIBILITIES OF THE SIGNAL/NOISE RATIO IN A PARTICLE IDENTIFICATION EXPERIENCE. Escudie, B.; Chery, R. (Institut de Physique Nucleaire, Lyon). Onde Elec., 1180-3(Nov. 1966). (In French).

Using the statistical properties of signals and noises obtained at the output of particle detector in a particle identification experience, one shows that correlation permits to extract the signal corresponding to $E \cdot dE/dx$ of the parasitic noises. This method gives an improvement of signal/noise ratio being interesting for low energy reaction study. (auth)

6220 ENERGY RESOLUTION OF SCINTILLATION COUNTERS. Moatti, P. Onde Elec., 1202-16(Nov. 1966). (In French).

The factors of energy resolution of scintillation counters are analyzed, by means of convenient characteristic functions. The classical formulas are found again, and completed by the influence of the energy distribution of luminous photons, and of space fluctuations of the different transfer efficiencies. Photomultiplier contribution and intrinsic resolution of scintillators are discussed. Generality of Bisi-Zappa effect for γ-rays, and weak importance of scintillator non-linearity for alkaline iodides, are shown. Prospects of energy resolution improvement are given. (auth)

6221 COMPARISON OF CALCULATED AND EXPERIMENTAL SCINTILLATION CRYSTAL PHOTOFRACTIONS. Snyder, B. J. (Division of Reactor Development and Tech., Washington, D. C.). Nucl Instrum. Methods, 46: 173-6(1967).

A comparison is presented of some calculated and experimental photofractions for gamma rays interacting in solid cylindrical NaI(Tl) scintillation crystal detectors. (B.G.D.)

6222 NEW TYPE OF DETECTOR FOR SLOW NEUTRONS. Rauch, H.; Grass, F.; Feigl, B. (Oesterreichische Hochschule, Vienna). Nucl. Instrum. Methods, 46: 153-6(1967). (In German).

A neutron-detection method with several marked advantages over current methods is described. The method is based on the measurement of the conversion electrons formed during neutron capture in Gd. The conversion electrons are determined by means of surface barrier detectors. This method enables a detection probability of up to 70%. The main advantage of this detector system is its small size, rendering a low weight detector shielding system and the exact measurement of the place of the possible neutron absorption. This may be of interest for time-of-flight measurements. (auth)

6223 PULSE SHAPE DISTRIBUTIONS FROM GAMMA-RAYS IN LITHIUM DRIFTED GERMANIUM DETECTORS. Strauss, M. G.; Larsen, R. N.; Sifter, L. L. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 46: 45-54(1967).

Pulse shape distributions resulting from the interaction of γ-rays in planar germanium detectors were studied as a function of field intensity, γ-ray energy, and detector width. It was observed that at 2300 V/cm the initial rate of charge collection approached 10 nsec/mm. Due to a slow component the total charge collection was about 30% longer. At 1000 V/cm the collection time was somewhat longer, and at 250 V/cm it was considerably longer. These observations appeared to be independent of γ-ray energy in the range of 0.6 to 3 MeV and detector widths of 3 to 11 mm. Events interacting near the center of the detector result in fast rising pulses and those interacting near one of the electrodes have a rise-time which is approximately twice as long, thus giving rise to a distribution of pulse shapes. With low energy γ-rays all shapes occur with equal probability, but at higher energy the pulses tend to have a more uniform shape. Due to the spread in risetimes, signals from monoenergetic γ-rays do not cross a given pulse height level at the same time and therefore produce timing uncertainties. With a 1 cm detector timing uncertainties of more than 30 nsec were observed at the 50% level, and less than 5 nsec at the 5% level. It therefore appears that for accurate timing of all signals, the timing discriminator should be set at the lowest level consistent with the system noise. The variations in risetime can also affect the energy resolution. If a 1 cm detector is used in conjunction with a pulse shaping network consisting of a 1 μsec RC differentiator and integrator, the variations in risetimes may cause an amplitude spread on the order of 0.03%. At γ-ray energies of 10 MeV this is comparable to the spread due to statistics. (auth)

6224 PROTON RECOIL SPECTROMETER FOR NEUTRON SPECTRA BETWEEN 50 AND 450 MeV. Gibson, W. A. (Oak Ridge National Lab., Tenn.); Burrus, W. R.; Wachter, J. W.; Johnson, C. F. Contract W-7405-eng-26. Nucl. Instrum. Methods, 46: 29-42(1967). (ORNL-TM-1525).

A proton recoil spectrometer was constructed and used to obtain energy spectra of neutrons emitted from targets bombarded by 160- and 450-MeV protons. The instrument employs a polyethylene radiator as the source of the recoil protons and measures the energy of the protons from the pulse height obtained when the proton passes through a thin NaI(Tl) crystal. The details of constructing the spectrometer and the circuitry used during operation are discussed. A Monte Carlo program for calculating the efficiency and resolution of the spectrometer is described. The effect of the Landau spread in the energy deposited in the NaI(Tl) energy detector is included in the resolution calculation. Typical energy spectra for secondary neutrons and protons are presented and the unfolding program used to compensate for the skewed energy resolution function of the spectrometer is discussed. (auth)

6225 BEAM POSITION INDICATOR AND STABILIZER IN A SCATTERING CHAMBER. Kumabe, I. (Kyoto Univ.). Nucl. Instrum. Methods, 46: 177-8(1967).

A beam position and stabilizer system, incorporating Yagi's method for reducing the ambiguity in inelastic scattering spectrum measurements, was constructed and used for achieving an incident beam of excellent quality in a scattering chamber. (B.G.D.)

6226 SOFT X-RAY SPECTROMETER WITH PHOTON COUNTING USING A RESISTANCE STRIP MAGNETIC ELECTRON MULTIPLIER. Campbell, J. K. R.; Watson, L. M.; Fabian, D. J. (Univ. of Strathclyde, Glasgow). J. Sci. Instrum., 44: 21-5(Jan. 1967).

The design of a soft x-ray spectrometer for the study of valence bands of metals and alloys is described. The instrument uses a blazed concave replica grating at grazing incidence with an electromagnetic photomultiplier as detector. Instrumental response and resolution are discussed with reference to ratemeter, electrometer and scaler recording techniques. K spectra of Be and $L_{2,3}$ spectra of Mg and Al are presented and important features of these spectra discussed. (auth)

6227 STATISTICALLY EFFICIENT USE OF REFERENCE PULSES IN SPECTROMETER STABILIZATION. Dudley, R. A. (International Atomic Energy Agency, Vienna). Nucl. Instrum. Methods, 46: 116-20(1967).

In nuclear radiation spectrometry, the performance of detector and multichannel pulse height analyzer is often improved by use of a feedback gain stabilizer. The process of stabilization, in which a reference peak in the spectrum is held in a prescribed channel, is necessarily accompanied by hunting. This has two related deleterious effects: each peak becomes broader and the mean channel number of the peak center fluctuates from one measurement to the next. Minimization of these effects was sought by automatic statistical analysis of the reference pulses before a feedback correction is introduced and selection of reference pulses only from favorable regions of the peak. The statistical merits of these procedures are evaluated. (auth)

6228 NUCLEAR RADIATION DETECTION BY SOLID-STATE DEVICES. Dearnaley, G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Sci. Instrum., 43: 869-77(Dec. 1966).

The history of the development of solid state devices for nuclear radiation detection is traced from crystal counter to the latest semiconductor detectors. The physical processes which are involved in the detector are then outlined, and the features which are desirable are discussed. Some commonly used procedures for detector fabrication are described, and attention is drawn to certain problems which remain. Finally, some recent and novel applications of these detectors are briefly described. (auth)

6229 ADVANCES IN THE DESIGN AND PERFORMANCE OF X-RAY PROPORTIONAL COUNTERS. Culhane, J. L. (London Univ.); Herring, J.; Sanford, P. W.; O'Shea, G.; Phillips, R. D. J. Sci. Instrum., 43: 908-12(Dec. 1966).

The development of proportional counters for the detection of soft x rays in space has led to some advances in the design and performance of these counters. The energy resolution of proportional counters at soft x-ray wavelengths is discussed. Sealed plastic-windowed counters are described and their deterioration with storage, and recovery treatment, investigated. The effect of high-count rate operation on counter-gas gain is examined and the design of large-area counters discussed, together with the problem of background reduction. Data on the performance of a small-volume counter for use with a grazing incidence "x-ray telescope" are presented. (auth)

6230 AUTOMATIC CONTROL FOR MAGNETIC β-SPECTROMETER MEASURING CONVERSION ELECTRON SPECTRA. Adam, I.; Denisov, Yu. N.; Kokesh, A.; Chumin, V. G.; Shishlyanikov, P. T. (Joint Inst. of Nuclear Research, Dubna, USSR. Inst. of Nuclear Research, Czechoslovak Academy of Sciences). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 2147-56(Dec. 1965). (In Russian).

Replacement of the manual control in the measurement of conversion electrons, which usually lasts for several days, with an automatic system makes it possible to eliminate subjective errors and to reduce the duration of the experiments. Such a system was installed in the iron-core, $\pi\sqrt{2}$ -type β spectrometer used at the Radiochemical Laboratory of the Joint Institute. It includes a stabilized supply for the windings of the electromagnet, allowing both manual and automatic adjustments, and possesses an information-recording and -analyzing system connected to a computer. Its central control system synchronizes and controls the calculating, information-output and current-adjusting operations. The components were installed in September 1964; their continuous operations showed that the system is reliable, easy to operate, and reduces the time needed for experiments by shortening the required exposure times. (TTT)

6231 A SILICON PROBE DETECTOR FOR β-COUNTING AND γ-DOSIMETRY. Parker, R. P. (Royal Cancer Hospital, Belmont, Eng.). pp.448-57 of Med. Electron., Proc. 5th Intern. Conf. Liege, 1963. Liege, Ed. Desoer.

Advantages and disadvantages of solid-state radiation transducers for the detection and spectrometry of β-particles are considered, with special reference to the problems encountered in medical physics. A description is given of a cylindrical surface-barrier detector constructed from silicon. The detector is 10 mm long, 2.8 mm in dia, and encapsulated in stainless steel; its performance with regard to the assay of a solution of ^{32}P was examined. It was shown that a sensitivity of 0.6-0.7 cps/mμC-ml ^{32}P is possible, although in practice this performance is not attained due to the noise level, especially at body temperature. The performance of the silicon detector is shown to be competitive with that of existing G-M counters of comparable dimensions. Ways by which the performance might be improved are considered and mention is made of the application of the device to γ-dosimetric problems. (BBB)

6232 RECORDING DEVICE FOR FISSION FRAGMENTS IN AN INTERNAL BEAM OF 310 CM CYCLOTRON. Imaev, E. G.; Fefilov, B. V.; Chelnokov, L. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 5, 19-26(Sept.-Oct. 1966). (In Russian).

Descriptions are given of electronic instrumentation used for recording spontaneous fission of element 102 with mass number 256, formed in the reaction $^{238}U(^{22}Ne, 4n)102^{256}$. The instrument is a multidimensional analyzer designed for simultaneous recording of fission fragments with accuracies of up to 10% and half life with an accuracy of 0.1 sec. The event parameters are recorded on paper tape at a rate of 1 event/sec. (R.V.J.)

6233 ELECTRON DETECTOR FOR A SATELLITE EXPERIMENT. Burger, J. J. (Werkgroep Kosmische Straling, Delft, Netherlands). Ned. Tijdschr. Natuur., 32: 184-90(May-June 1966). (In Dutch).

An electron detector designed to be used in a satellite experiment is described in detail. The detector consists of a thin CsI detector, a thick CsI detector, a glass scintillation counter, a Cherenkov counter, and a plastic scintillator shield counter. The operation of the detector is discussed. (J.S.R.)

6234 ELECTRONIC DEVICE WITH A MULTICHANNEL ANALYZER FOR THE DETERMINATION OF TWO MIXED RADIOISOTOPES BY MEANS OF HALF-LIFE MEASUREMENTS. Greco, Giuseppe; Oliveri, Elio (Univ., Palermo, Italy). Atti Accad. Sci., Lettere Arti Palermo, Pt. 1, 24: 75-83(1963/64). (In Italian).

An electronic device, that allows the simultaneous measurement of short, almost coincident, half lives of two mixed radioisotopes, is described. Experiments carried out on mixed ^{28}Al and ^{52}V are in accordance with data of literature. (auth)

6235 SELF-STARTING STREAMER CHAMBER. Bobrov, V. D.; Butikov, Yu. A.; Dolgosheni, B. A.; Luchkov, B. I.; Rodionov, B. U. Prib. Tekh. Eksp., No. 5, 222-3(Sept.-Oct. 1966). (In Russian).

A description is given of a new method for spark chamber startup using inert gases (He, Ar, Xe, and Ne) and their mixtures as working gases in the chamber itself. The combined spark chamber and gaseous scintillator were used for recording short-track α particles. The pictures of α tracks in neon gas at various high-voltage pulse periods and a detailed picture of α tracks in helium gas are included. (R.V.J.)

6236 RESONANCE COUNTER FOR ^{57}Co GAMMA RADIATION. Mitrofanov, K. P.; Rokhlov, N. I. (Moscow State Univ.). Prib. Tekh. Eksp., No. 5, 223-5(Sept.-Oct.,1966). (In Russian).

The performance of a selective γ-quanta (resonance) counter based on the recording of internal conversion electrons accompanying γ resonance was analyzed. The optimum parameters were found for the resonance counter with a ^{57}Co source. Absorption spectra of recoilless gamma rays emitted from the ^{57}Co source and measured by the resonance counter coated with ^{57}Fe enriched Fe_2O_3 of various thicknesses are presented. (R.V.J.)

6237 SYSTEM FOR MEASURING STABILIZATION AND AUTOMATIC REARRANGING OF MAGNETIC FIELD ELECTROMAGNETS. Afanas'ev, N. G.; Denyak, V. M.; Startsev, V. I. (Inst. of Physics and Tech., Kharkov). Prib. Tekh. Eksp., No. 5, 198-203(Sept.-Oct. 1966). (In Russian).

A description is given of a system for the exact measurement, stabilization, and automatic retuning of magnetic fields for 10 to 100 kW magnetic spectrometers. The system is capable of rearranging a field at 2 to 6 and 6 to 13 kOe, stabilize it with an accuracy of about 0.01%, and produce an automatic signal in case of knockout. The system tested with two magnetic spectrometers used for the analysis of charged particles up to 100 MeV/c and for 400 MeV/c proved to be efficient and stable. (tr-auth)

6238 SECONDARY EMISSION OF HEAVY CHARGED PARTICLE UHF DETECTOR. Vorob'ev, A. A.; Korolev, G. A.; Lebedev, A. K. (Inst. of Physics and Tech., Leningrad). Prib. Tekh. Eksp., No. 5, 85-9(Sept.-Oct. 1966). (In Russian).

A description is given of a microwave secondary emission heavy charged particle detector, in which the particle passing through a thin foil knocks out the secondary electrons which in turn enter the gap in a uhf resonator. The entering electrons acquire different energies depending on the phase of the uhf field. An electrostatic analyzer and secondary emission multiplier separate electrons of certain energy which correspond to the short phase interval of the uhf field. Detector operation was tested with 5-MeV α particles. The time resolution was 2×10^{-11} sec at recording efficiency of 8%. (tr-auth)

6239 CHERENKOV COUNTER FOR HIGH-ENERGY ELECTRONS. Afanas'ev, N. G.; Denyak, V. M.; Reva, D. P.; Savitskii, G. A.; Startsev, V. I.; Shevchenko, N. G. (Inst. of Physics and Tech., Kharkov). Prib. Tekh. Eksp., No. 5, 90-4(Sept.-Oct. 1966). (In Russian).

The design and performance of a Cherenkov detector for fast electrons at the exit of a magnetic spectrometer are described. The counter is able of recording > 100-MeV electrons from a linear ~1 μ sec pulse accelerator. The counter resolving time is 50 nsec, recording up to 4 pulses per accelerator pulse. The electron counter contains a 1:4 tunnel diode scaling scheme with resolving time of 30 nsec. The pulse formation and penetration scheme synchronize the counter and electron accelerator operations. (tr-auth)

6240 BACKGROUND CHARACTERISTICS OF INDUSTRIAL GAS-FILLED COUNTERS. Viktorov, S. V.; Kocharov, G. E.; Naidenov, V. O. (Inst. of Physics and Tech., Leningrad). Prib. Tekh. Eksp., No. 5, 95-6(Sept.-Oct. 1966). (In Russian).

Tests were made of the background of shielded and nonshielded counters. The obtained data showed that shielding screens reduced the background of the industrial gas-filled counters 3 to 4 times.

Further reduction was achieved by a system of active shielding. The sensitivity of counters to cosmic radiation hard and soft components was identical in all counters. The contribution to background by nonshielded counters was about 55 to 60%. (tr-auth)

6241 EFFECTS OF ELECTRIC FIELDS ON SCINTILLATIONS. Grigor'ev, V. A.; Lyapidevskii, V. K.; Obodovskii, N. M.; Ryl'tsov, V. V. (Inst. of Engineering Physics, Moscow). Prib. Tekh. Eksp., No. 5, 97-9(Sept.-Oct. 1966). (In Russian).

Studies of electric field effects on various types of scintillations from monocrystals of NaI(Tl), CsI(Tl), and CsI(In) showed that the field reduced scintillator pulse amplitudes. An analysis was made of the reduced pulse as function of the field intensity, photo multiplier anode chain reactive current, and excited radiation ionization density. (tr-auth)

6242 SPARK CHAMBER AS SHOWER DETECTOR OF HIGH-ENERGY ELECTRONS AND PHOTONS. Gapotchenko, A. G.; Govorkov, B. B.; Denisov, S. P.; Kotel'nikov, N. G.; Stoyanova, D. A. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 5, 60-6(Sept.-Oct. 1966). (In Russian).

The application of a spark chamber as a shower detector for γ quanta and electrons at energies of 50 to 200 MeV is discussed. The total number of sparks formed in the chamber during recording of the shower describes the energy of the primary particles and indicates a linear relation between the number of sparks per shower and the primary particle energy. The fluctuations of the total number of sparks in relation to the mean value follows Poisson's law. The formula was normalized for evaluating the electrode thickness of the spark chamber which is necessary for assigned energy resolution. (tr-auth)

6243 INSTALLATION OF WIRE SPARK CHAMBERS WITH AN ANALOG OUTPUT OF INFORMATION FOR MEASURING PARTICLE MOMENTUM AND ANGLES. Golutvin, I. A.; Zanevskii, Yu. V.; Kulakov, B. A.; Tsyganov, E. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 5, 66-71(Sept.-Oct. 1966). (In Russian).

Tests were made on a beam from a synchrophasatron with 4 wire spark chambers designed for rapid particle momentum recording. The device uses ferrite rings and an analog output. The recording time is < 1 μsec with particle angle of deviation acting as an output signal. The order of precision for the particle angle of deviation with 1 m distance between the two chambers is ± 2 mrad. The device may be used for resolving problems of elastic scattering, new resonances, and for the startup of complete spark chamber systems. (tr-auth)

6244 SHIFT OF DISCHARGE IN SPARK CHAMBER IN MAGNETIC FIELD. Korenchenko, S. M.; Morozov, A. G.; Nekrasov, K. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 5, 72-4(Sept.-Oct. 1966). (In Russian).

Experimental data are given on the shift of spark chamber discharge in crossed magnetic and electric fields. The Townsend formula was used for determining the shift according to the known field and gas parameters. The mean frequency of electron interactions with gas atoms given as a function of the magnitude of magnetic field and calculations using the Townsend formula were in good agreement with the experiment for chambers filled with inert gases. (tr-auth)

6245 SYMMETRIC SYSTEM OF WIRE ELECTRODES IN ISOTROPIC SPARK CHAMBER. Matyushin, A. T.; Matyushin, V. T. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 5, 75-8(Sept.-Oct. 1966). (In Russian).

The possibility of constructing isotropic spark chamber was analyzed. It is shown that a chamber with a system of wire electrodes eliminates a series of errors inherent to the open system and results in more accurate data for track coordinates, especially in z-projection. (tr-auth)

6246 SEMI-AUTOMATIC DEVICE FOR SCANNING AND MEASURING PICTURES TAKEN IN SPARK CHAMBERS. Legar, F.; Maly, M.; Sgon, O. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 5, 78-82(Sept.-Oct. 1966). (In Russian).

A semi-automatic 410 × 300 × 550 mm^3 and 22.5 kg device was designed for recording broken track angles photographed by a standard 18 × 22 mm^2 movie camera with perforated 35 mm film and magnified 10 fold on the screen of the device. (R.V.J.)

6247 SEALING OF ILLUMINATORS FOR LARGE HYDROGEN BUBBLE CHAMBERS. Lebedev, R. M.; Saitov, I. S.; Ustenko, E. P.; Shishov, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 5, 82-5(Sept.-Oct. 1966). (In Russian).

Sealing of illuminators in 1 and 2 meter bubble chambers by insertion of three-layer indium packing along the flexible metal surface between the glass and the frame is described. The seal was achieved by blowing in helium under high pressure into a cooled chamber. The seal as liquid nitrogen temperature produced good results. (tr-auth)

6248 CORRECTIONS FOR THE GEOMETRIC DISTORTIONS IN SPARK CHAMBER PICTURES. Bystritskii, I.; Legar, F.; Maly, M.; Sgon, O.; Yanout, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 5, 55-9(Sept.-Oct. 1966). (In Russian).

Geometric distortions appearing in track photographs taken in spark chambers were studied, and formulas were developed for the oblique-angle and plane track distortions. An analysis is made of the optical image corrections for elastic p-n scattering. (tr-auth)

6249 INSTALLATION FOR AUTOMATIC DETERMINATION OF THE ANGLE OF INCIDENCE OF WIDE ATMOSPHERIC COSMIC SHOWER AXES. Dovzhenko, O. I.; Yudin, E. P. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 5, 50-5(Sept.-Oct. 1966). (In Russian).

A description of a chronotron-type installation for determining the azimuthal and zenith incident angles of wide atmospheric cosmic showers is presented. The method for recording the data in a binary code is discussed. (tr-auth)

6250 MAGNETIC SPECTROMETERS FOR PARTICLES WITH UP TO 400 MeV/c PULSES. Afanas'ev, N. G.; Gol'dshtein, V. A.; Savitskii, G. A.; Stepula, E. V.; Khvastunov, V. M.; Shevchenko, N. G. (Inst. of Physics and Technology, Kharkov). Prib. Tekh. Eksp., No. 5, 44-50(Sept.-Oct. 1966). (In Russian).

The construction and operation of an experimental magnetic spectrometer with homogeneous field and double-focusing is discussed. The resolving characteristics of the spectrometer for 4.5 and 6 mm sources is equal to 0.14 and 0.19%, respectively, at 2.90×10^{-3} sterad. (tr-auth)

6251 TRACK ETCHING; SOME NOVEL APPLICATIONS AND USES. Furman, S. C.; Darmitzel, R. W.; Porter, C. R.; Wilson, D. W. Trans. Amer. Nucl. Soc., 9: 598-9(Oct.-Nov. 1966).

6252 TECHNIQUE TO DETERMINE SLOW-NEUTRON SPECTRA FROM FOIL ACTIVATIONS. Fulmer, Richard H.; Ruane, T. F. (Knolls Atomic Power Lab., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 9: 497-8(Oct.-Nov. 1966).

6253 FLUX WIRE AND AERO-BALL® ACCURACY FOR IN-CORE POWER MONITORING. Leggett III, W. D. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 484-5(Oct.-Nov. 1966).

6254 RADIATION ENDURANCE OF LOW RESISTIVITY SILICON DIODES FOR NEUTRON MONITORING. Epstein, L. M.; Ferber, R. R. (Westinghouse Research Labs., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 483-4(Oct.-Nov. 1966).

6255 THRESHOLD DETECTOR FOR HIGH-ENERGY GAMMAS. Lehto, Wayne K.; Carpenter, J. M. (Univ. of Michigan, Ann Arbor). Trans. Amer. Nucl. Soc., 9: 478-9(Oct.-Nov. 1966).

6256 CALIBRATION OF A LARGE PROTON RECOIL DETECTOR FOR FAST-NEUTRON SPECTRA MEASUREMENTS. Augustson, R. H.; Gaerttner, E. R.; Gozani, T.; Kaushal, N.; Malaviya, B. K.; Winhold, E. J.; Yergin, P. F. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 9: 478(Oct.-Nov. 1966).

6257 RESPONSE TO ENVIRONMENT AND RADIATION OF AN IONIZATION CHAMBER AND MATCHED GEIGER TUBE USED ON SPACECRAFT. Anderson, H. R. (Rice Univ., Houston, Tex.); Despain, L. G.; Neher, H. V. Nucl. Instrum. Methods, 47: 1-9 (Jan. 1967).

The construction and operation of the ion chambers and Geiger-Müller tubes used on Mariner II and IV and the OGO-C and D spacecraft are described and the sensitivity of the instruments to their environment is listed. The procedure used to calibrate the sensors in absolute units is explained, and the response of the detectors to unit flux of protons, electrons, and photons as a function of energy of the incident radiation is presented in graphical form. (auth)

6258 FAST PULSE PICKOFF WITH SEMICONDUCTOR RADIATION DETECTORS. Quaranta, A. Alberigi; Martini, M.; Ottaviani, G. (Univ., Bologna). Nucl. Instrum. Methods, 47: 10-12(Jan. 1967).

The problem is investigated of extracting a fast signal at the same time of the energy signal from a solid state detector. The effect of the charge amplifier on this waveform is accounted for. A new method is suggested for achieving fast timing with this kind of detectors. (auth)

6259 ARRAY DETECTORS AND EXTENDED SOURCE USED IN A DOUBLE FOCUSING BETA SPECTROMETER. Nilsson, O.; Karlsson, S.-E.; Andersson, I.; Nordling, C.; Siegbahn, K. (Uppsala Univ.). Nucl. Instrum. Methods, 47: 13-22(Jan. 1967).

The 50-cm iron-free beta spectrometer at Uppsala has been furnished with an array of close-lying semiconductor detectors and an extended source arrangement. The combined detector and source system increases the amount of information per time-unit more than 100 times. A description of the detector and source arrangements is given together with some applications. (auth)

6260 THEORETICAL RESPONSE OF A PHOTOMULTIPLIER TO LIGHT PULSES HAVING A TIME DURATION CLOSE TO THE RESOLUTION TIME. STUDY OF FLASHES OF DURATION OF NANOSECOND ORDER. Parrot, Robert (Faculte des Sciences de Poitiers, Vienna). Compt. Rend., Ser. B, 263: 795-8(Oct. 3, 1966). (In French).

A method is proposed for analyzing anode pulses of the order of nanoseconds corresponding to exponential emissions and to step emissions followed by a decreasing exponential. Some graphs allow one to find the time constant of the exponentials as well as the duration of the steps once the rise time (10 to 90%) and the duration of the experimental anode pulses at mid height are known. An example is given to clarify each type. (tr-auth)

6261 PERFORMANCE OF DIAMOND COUNTER FOR NUCLEAR PARTICLES AT HIGH TEMPERATURE. Afanaseva, E. A.; Agababyan, E. V. (Erevan State Univ.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 261-3(1966). (In Russian).

The maximum pulse-height dependence upon the applied voltage for diamond counters by irradiation of α particles of ^{238}Pu and ^{242}Pu was obtained in the temperature range +20°C to +230°C, the energy resolution being about 10% at the temperature +160°C. (auth)

6262 CORRECTION FACTORS FOR CONVERTING MEAN TO INSTANTANEOUS COUNTING RATES IN THE MEASUREMENT OF SHORT-LIVED ISOTOPES. Marais, P. G.; Haasbroek, F. J.; de V. Smit, W. B. (Fruit and Food Tech. Research Inst., Stellenbosch, S. Afr.). Technol. Commun., Dept. Agr. Technol. Serv., (S. Afr.), No. 50, 12p(1965).

The conversion of mean to instantaneous counting rates when the counting period is comparable to the half life is discussed in detail. The various expressions used are simplified, and the final conversion formula contains factors to account for decay of the sample during measurement, resolving time counting losses, and an error term which compensates for the error introduced by using the mean counting rate to calculate the resolving time loss. Tables containing appropriate correction factors are supplied. (TSS)

6263 EXTENDED DETECTORS IN NEUTRON TIME-OF-FLIGHT DIFFRACTION EXPERIMENTS. Carpenter, J. M. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods, 47: 179-80(Jan. 1967).

Equations for the locus of constant time of arrival for neutron time-of-flight diffraction are derived in order to determine the position for placing an array of detectors which would yield the best resolution and higher counting rates. (L.B.S.)

6264 FABRICATION OF GERMANIUM Li-DRIFTED DETECTORS. Cappellani, F.; Fumagalli, W.; Henuset, M.; Restelli, G. (CCR-EURATOM, Ispra, Italy). Nucl. Instrum. Methods, 47: 121-4(Jan. 1967).

A detailed description of the procedures used in constructing GeLi detectors is given. Planar and coaxial type detectors with active volumes up to 5 cm^3 and 18 cm^3 respectively have been obtained. Optimum resolutions for 120 keV and 1.330 keV gammas were: 3 keV and 4 keV for a planar 2 cm^3 detector and 4 keV and 7 keV for a coaxial 18 cm^3 detector, using a tube type preamplifier. (auth)

6265 COMPUTER-COUPLED QUALITY CONTROL PROCEDURE FOR GAMMA-RAY SCINTILLATION SPECTROMETRY. Covell, D. F. (Naval Radiological Defense Lab., San Francisco). Nucl. Instrum. Methods, 47: 125-32(Jan. 1967).

Long-term stabilization of instrumental performance is necessary for gamma-ray scintillation spectrometry whether used for nuclear spectroscopy studies or for radionuclide identification and estimation. This requirement is especially important if high precision measurements are to be made on a routine basis. It is proposed to achieve sufficient stabilization through statistical quality control, a technique used to maintain the quality of output of a process or system. A quality control procedure was devised which consists of periodic measurement of a current standard spectrum and comparison of it, on a channel-by-channel basis on a computer, with a reference standard spectrum. Significant differences between the two spectra are interpreted as machine deviations that require correction. As part of the procedure, values obtained from this measurement are charted so that current and past performance can be compared easily. This makes possible a prompt awareness of unusual changes in performance. Application of the technique has resulted in improved stability, improved reliability, and reduced maintenance. Approximately 20 min of technician time are required per day to apply this procedure to a single instrument. Less time per instrument is required when several instruments are simultaneously controlled. (auth)

6266 SCATTERING CHAMBER USING SEMICONDUCTOR DETECTORS. Haque, M. A. (Atomic Energy Center, Dacca, Pakistan); Holzer, O. H.; Hossain, A.; Sabir, A.; Siddiq, A. K. M. Nucl. Instrum. Methods, 47: 137-40(Jan. 1967). (AECD/EP-14).

The design and construction of a 24" dia scattering chamber which will be used primarily for angular distribution studies of neutron induced reactions are presented. Five semiconductor detectors can be used at a time to detect charged nuclear reaction products at different angles and at different distances with respect to the incident beam. The detectors are mounted on a rotating table which is graduated in degrees and is rotated externally. A liquid air trap is used in the vacuum system to prevent deposition of pump oil on the surface of the detectors. (auth)

6267 PHOTOGRAPHIC EMULSION PLATE CAMERA FOR GAS AND SOLID TARGETS. Sen Gupta, H. M. (Univ. of Dacca, Pakistan); Khan, A. H.; Hossain, A.; Sabir, A.; Khandaker, A. K. M. Nurannabi. Nucl. Instrum. Methods, 47: 133-6(Jan. 1967).

A camera was designed for studying scattering processes for both gas and solid targets over a wide range of angles using nuclear emulsion as detector. Performance of the camera was tested by studying elastic scattering of 2.6 MeV protons from xenon. The measured cross section as a ratio to $\mathrm{cosec}^4(\frac{1}{2}\theta)$ was found to be constant over a range of angles as expected. (auth)

6268 COUNTING ASSEMBLY FOR A COSMIC TELESCOPE COMPOSED OF TWO CIRCULAR DISKS. Heristchi, Dj. (Laboratoire de Physique Cosmique, Meudon, France). Nucl. Instrum. Methods, 47: 39-44(Jan. 1967). (In French).

The counting rate of a cosmic ray telescope composed of a two-circular detector is calculated as a function of the radiation intensity, the effective radius and the distance between the two counters. Formulas are presented for the isotropic radiation and in a field where radiation varies with the zenith angle in accordance with a squared cosine law. The information embodied in the formulas is also presented graphically either in terms of the dimensions or of the aperture of the telescope. (auth)

6269 COMPARISON OF TWO DETECTING METHODS FOR TIME-OF-FLIGHT MEASUREMENTS OF THERMAL NEUTRON SPECTRA. Heiberg, E. (Institutt for Atomenergi, Kjeller, Norway). Nucl. Instrum. Methods, 47: 89-92(Jan. 1967).

Neutron spectra from the graphite reflector in the Norwegian reactor JEEP 1 were measured by means of the conventional chopper technique. A comparison is made between the spectra obtained with a boron polyester scintillator and with a BF_3 detector placed at the end of the neutron flight path. Both detecting methods supplement each other at least for a straight slit chopper, as for a gamma sensitive detector the zero point of the time-of-flight scale automatically is given by the chopped gamma beam "peak." (auth)

6270 DECAY OF LUMINESCENCE INTENSITY IN ORGANIC SCINTILLATORS. Dupont, H.; Pfeffer, G.; Laustriat, G.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods, 47: 93-9(Jan. 1967). (In French).

The luminescence decay curves of various organic scintillators (single crystals, liquids, and plastics), excited by α-particles, γ-rays, and ultraviolet light flashes, were recorded on a time interval 0 to 180 ns. The oxygen effect on the slow component of solutions has been investigated. It is shown that, in most cases, the radioluminescence decay cannot be described by a sum of two exponential terms. The results are in agreement with a theory of the scintillation process, ascribing the slow component to a delayed emission from singlet states resulting from triplet-triplet annihilation. The times after which the scintillation intensity is reduced to 10 and 1% of its maximum value are given. (auth)

6271 NEW DOUBLE DELAY LINE AMPLIFIER USING ONE LINE ONLY. Gorni, S. (Hebrew Univ., Jerusalem). Nucl. Instrum. Methods, 47: 74-6(Jan. 1967).

A new double delay line amplifier is described. The double delay line bi-polar shaping is accomplished by one line only. The noise of the amplifier was better than that of the ordinary double delay line amplifier. The pulse width used in our amplifier was 50 ns and the rise time 10 ns. The amplifier was used as the

second stage after the solid state charge sensitive amplifier. (auth)

6272 CADMIUM FLUORIDE PHOTON SPECTROMETER. Mann, B.; Smith, A. M.; Stewart, D. T. (Univ. of Glasgow). Nucl. Instrum. Methods, 47: 183-4(Jan. 1967).

The performance of a photon spectrometer using a 15 × 15 cm cylindrical crystal of CdF_2 coupled to an EMI type 9618 TA photomultiplier was investigated. Pulse height spectra were recorded for energies between 40 and 150 MeV; examples of these spectra are given, which show that the resolution of the spectrometer varies from 25% at 65 MeV to 18% at 147 MeV. The linearity of the response of the spectrometer is shown together with the variation in resolution with electron energy. The overall performance of the spectrometer was found to be sufficiently successful for use in investigations on nuclear scattering of gamma rays. (L.B.S.)

6273 DUAL ELEMENT, COAXIAL, Ge (Li) GAMMA RAY SPECTROMETER. Lalovic, B. (Univ. of Toronto). Nucl. Instrum. Methods, 47: 173-5(Jan. 1967).

A method which allows the assembly of germanium gamma spectrometers with sensitive volumes much larger than those of existing spectrometers is described. This method consists of stacking two or more coaxially drifted germanium diodes and using them as a single detector. The energy dependence of the photopeak and second escape peak efficiencies of the dual element germanium spectrometer and of the constituent counters are shown. The absolute intrinsic efficiencies and the effect of increased solid angle are compared with the sum of the efficiencies of the individual counters. (J.F.P.)

6274 MOBILITY OF ELECTRONS AND HOLES AT 77 DEG K IN LITHIUM-COMPENSATED GERMANIUM. Kuchly, J. M.; Stab, L.; Henck, R.; Siffert, P.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods, 47: 148-50 (Jan. 1967). (In French).

The drift mobility of electrons and holes was measured at 77°K. The observed minority carrier mobility is less than the mobility calculated from scattering by phonons and impurity atoms. The discrepancy, which is greater than a factor of 5 in some cases, has been attributed to collisions with substitutional oxygen (which has been measured by lithium precipitation). (auth)

6275 PROPAGATION OF PULSES IN MAGNETOSTRICTION SPARK CHAMBERS. Giannelli, G.; Marangelli, B.; Ricco, M. (Univ., Bari, Italy. INFN, Bari, Italy. GIFCO, Bari, Italy). Nucl. Instrum. Methods, 47: 151-6(Jan. 1967).

The properties of the propagation of the elastic pulses in the wires of magnetostriction spark chambers were investigated. Wires of different compositions and diameters were examined. The pulse velocity and its variation with temperature and mechanical tension have been measured. The amplitude, duration, attenuation, and dispersion of the pulses were determined. Also an analysis was made of the mechanism of generation of the elastic pulses. (auth)

6276 SIMPLIFIED ACCURACY ESTIMATION FOR THE LOGARITHMIC COUNTING-RATE METER. Vincent, C. H. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Instrum. Methods, 47: 157-63(Jan. 1967).

An analysis is given of the random fluctuations in the output of the saturating diode-pump type of logarithmic ratemeter of Cooke-Yarborough and Pulseford. The results of this analysis are in agreement with those in the more recent paper by Offner, rather than those originally obtained by Cooke-Yarborough and Pulseford. The correct formula for the random fluctuation as a function of the mean input pulse rate is a very complicated one, but it is shown that an accurate plot of the fluctuation over the range of the instrument can be obtained by following a few simple arithmetical rules, derived from this formula. (auth)

6277 DERIVATIVE MOESSBUAER SPECTROMETER. Bressani, T. (Univ., Cagliari, Italy); Brovetto, P.; Chiavassa, E. Nucl. Instrum. Methods, 47: 164-8(Jan. 1967).

A technique for Moessbauer spectrometry employing the same modulation procedure normally used in electron spin resonance spectrometers is described with some details. The results concerning the ^{57}Fe γ-ray absorption spectrum of metallic iron are reported. (auth)

6278 FAST TRIGGERING DEVICE FOR SPARK CHAMBERS. Allkofer, O. C.; Knoblich, P.; Kraft, E. (Univ., Kiel). Nucl. Instrum. Methods, 47: 169-70(Jan. 1967).

A circuit is described that can be used well for triggering spark chambers with primary ionization. The measured values of delay time at various input voltages are shown. The power consumption of the total trigger circuit including high voltage and operating voltage is roughly 2.5 W. (L.B.S.)

6279 REDUCTION OF PILE-UP EFFECTS IN TIME AND ENERGY MEASUREMENTS. Moszynski, M. (Inst. for Nuclear Research, Warsaw); Jastrzebski, J.; Bengtson, B. Nucl. Instrum. Methods, 47: 61-70(Jan. 1967).

Two circuits for the reduction of pile-up effects are described. Circuit I was designed for a time-to-pulse height converter working with plastic scintillators. Circuit II was designed for a NaI(Tl) gamma-ray spectrometer. An analysis of pile-up phenomena related to a time-to-pulse height converter is presented. In particular, the influence on these phenomena of the slow coincidence resolving time and of the coupling time constant between the photomultiplier anode and limiter grid was investigated. (auth)

6280 MEASUREMENT OF ^{24}Na AND ^{42}K WITH A LIQUID-SCINTILLATION COUNTING SYSTEM WITHOUT ADDED SCINTILLATOR. Garrahan, P. J.; Glynn, I. M. (Cambridge Univ., Eng.). J. Physiol. (London), 186: 55P-56P(Oct. 1966).

Isotopes such as ^{24}Na and ^{42}K, which are usually counted with a well-type counter, can be counted with higher efficiency using a liquid scintillator but the method has disadvantages. Several disadvantages may be avoided by omitting the liquid scintillator. With ^{24}Na the relatively hard radiation (γ = 1.37 and 2.75 MeV; β = 1.39 MeV) excites the glass of the vial or the quartz face of the photomultiplier tubes, or gives rise to Cherenkov radiation, sufficiently to be counted with an efficiency of about 26%. This is less than the efficiency obtained with a conventional NaI crystal counter (about 40%), but the background is lower and the max volume of fluid that can be counted is greater. Potassium-42 (γ = weak 0.32 MeV and 18% 1.52 MeV, β = 18% 2.0 MeV and 82% 3.6 MeV) without liquid scintillator is counted with an efficiency of about 62%, compared with an efficiency of about 22% with a NaI crystal. The high efficiency obtained with ^{42}K is probably accounted for by Cherenkov radiation produced by the very hard β particles. Means are described for avoiding calculation of clock time and preventing interference between samples in an automatic sample changing apparatus. (BBB)

6281 DETERMINATION OF PARAMETERS OF α SPECTROMETERS BY MEANS OF ^{226}Ra AND RdTh SOURCES. Volkova, E. A.; Ziv, D. M.; Labushkin, V. G.; Ruzer, L. S.; Stepanov, E. K.; Tyutikov, N. V. (All-Union Research Inst. of Physico-Technical and Radiotechnical Measurements, Mendeleevo, USSR). Prib. Tekh. Eksp., No. 4, 36-9(July-Aug. 1966). (In Russian).

Basic parameters of semiconductor α spectrometers were determined at wide energy range (4.78 to 8.78 MeV) by means of non-emanating ^{226}Ra and RdTh sources. (tr-auth)

6282 EFFICIENCY OF SECONDARY EMISSION MONITOR. Afanas'ev, N. G.; Kovalev, V. D.; Savitskii, G. A.; Khvastunov, V. M.; Shevchenko, N. G. (Inst. of Physics and Technology, Kharkov). Prib. Tekh. Eksp., No. 4, 29-31(July-Aug. 1966). (In Russian).

The efficiency of a secondary emission monitor equipped with gold foil emitters was measured using an electron linear accelerator with energies of 100, 150, and 200 MeV. A Faraday cup was used as an absolute integrator of the electron beam current. The secondary emission coefficient was studied as a function of the collector intensity, energy, electron beam intensity, and of the beam position on the foils. (tr-auth)

6283 STUDIES OF A SECONDARY EMISSION MONITOR FOR ELECTRON BEAMS. Arkatov, Yu. M.; Vatset, P. I.; Voloshchuk, V. I.; Marchenko, V. L.; Nikitin, V. A.; Chechetenko, V. F. (Inst. of Physics and Technology, Kharkov). Prib. Tekh. Eksp., No. 4, 27-8(July-Aug. 1966). (In Russian).

The coefficient of secondary emission of a monitor with aluminum foil was studied as a function of the primary electron energy, accelerator current, and the beam position in the foils. The experiments were carried out with an electron linear accelerator. The accelerator operated with single pulses and with 50 pulses/sec. (tr-auth)

6284 USE OF GaAs LIGHT SOURCES FOR CALIBRATING DEVICES WITH SEMICONDUCTOR NUCLEAR-RADIATION DETECTORS. Naumov, V. I.; Omel'yanenko, M. N.; Rykalin, V. I.; Titova, V. F. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 4, 65-8(July-Aug. 1966). (In Russian).

The calibration of a telescope consisting of four trays of Si nuclear-radiation detectors by means of a GaAs light source is described. The recombination-light source was made from n-type GaAs that had a majority-carrier concentration of (1 to 3) × 10^{17} per cm^3 and a mobility of 0.35 m^2/V sec; a plot of light-pulse height vs temperature is shown. The telescope is calibrated by constant-height light pulses simulating the passage of nuclear particles through semiconductor detectors; a simplified light-pulse-generator circuit is supplied. The amplitude character-

istic of the generator is stabilized within 10 to 40C; the detectors are electrically shielded. (ATD)

6285 SCINTILLATION DETECTOR OF $2m^2$ WORKING AREA POWERED BY REFLECTED LIGHT. Yudin, E. P. (Inst. of Physics, Academy of Sciences, USSR). Prib. Tekh. Eksp., No. 4, 62-4(July-Aug. 1966). (In Russian).

The design and operation of a $2m^2$ scintillation detector powered only by reflected light is described. The detector consists of 8 plastic blocks $50 \times 50 \times 5$ cm^2 each, FEU-3B, with white enameled light conductor (diffusion reflection factor $\alpha \sim 0.9$) with the photocathode covered with light-proof screens. The maximum pulse amplitude taken from the photomultiplier anode during the passage of single cosmic particles and the pulse amplitude as a function of the position of the cosmic meson passage through the scintillator were evaluated. (tr-auth)

6286 LARGE SCINTILLATION COUNTERS AND COUNTERS INTENDED FOR OPERATION IN MAGNETIC FIELDS. Bayatyan, G. L.; Galaktionov, Yu. V.; Zel'dovich, O. Ya.; Landsberg, L. G. (Bayatyan Inst. of Physics, Erevan, Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp., No. 4, 56-9 (July-Aug. 1966). (In Russian).

The results are reported of testing large (up to $700 \times 350 \times 15$ mm) scintillation counters with one photomultiplier and long-lightguide counters capable of operating in strong magnetic fields. The large counters with 190 to 250-mm lightpipes were illuminated by a gamma beam from ^{137}Cs; the irregularity of light collection was found to be 40% or less. The effect of the scintillation-crystal shape on the efficiency of particle recording was also explored. In the second type of counters, the ambient magnetic field was eliminated by either a compensating magnetic field derived from a special solenoid or by using lightguides long enough for locating the photomultiplier in a region permitting application of magnetostatic shields. In one case of magnetic compensation, the counter operated with an efficiency of 0.997. (ATD)

6287 SEMIAUTOMATIC MICROSCOPE FOR MEASURING THE MEAN ANGLE OF COULOMB SCATTERING OF CHARGED PARTICLE TRACKS IN NUCLEAR MIRE-2 PHOTOEMULSIONS. Dolinskii, I. M.; Raguzin, R. M.; Sharygin, N. V.; Fedorova, N. M. (Leningrad Joint Optical Mechanical Industries). Prib. Tekh. Eksp., No. 4, 51-6(July-Aug. 1966). (In Russian).

A semiautomatic microscope for measuring the mean angle of multiple scattering in MIRE-2 photoemulsion is described and basic technical data of one of these manufactured devices are given. (tr-auth)

6288 SPARK CHAMBER WITH AUTOMATIC MEASUREMENT OF SPARK COORDINATES. Lepekhin, F. G.; Ovchinnikov, B. M. (Inst. of Physics and Tech., Leningrad). Prib. Tekh. Eksp., No. 4, 47-50(July-Aug. 1966). (In Russian).

An electronic analyzer is described which is intended for measuring and recording time intervals associated with propagation of shock waves from sparks to microphones in a filmless spark chamber. The interval storage unit has a capacity of 20 12-digit numbers and is designed with tunnel diodes. By filling the chamber with argon mixed with alcohol vapor, at 1.2 atm, a microphone signal as high as 0.3 V was obtained. The chamber was calibrated by 5 point-type spark dischargers. The adopted method of measurement permits eliminating the near-spark region of the shock-wave propagation. The time intervals are measurable with an error of 0.5 sec. The mean square error of determining one spark coordinate is 0.28 mm. (ATD)

6289 ANALYSIS OF LOW-ENERGY PARTICLE TRACKS IN A WILSON CHAMBER. Govorun, N. N.; Popova, I. V.; Smirnova, L. A.; Ryl'tseva, T. V.; Nikitin, V. A.; Nomofilov, A. A.; Sviridov, V. A.; Slepets, L. A.; Sitnik, I. M.; Strunov, L. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 4, 44-6(July-Aug. 1966). (In Russian).

A series of events observed in a Wilson chamber were studied taking into consideration the particle deceleration in the chamber and the inhomogeneity of the magnetic field. The recoil parameters of the particles were determined by minimization of the functional obtained from the deflection of the experimental points from the plane projection of the theoretical curve. The theoretical curve was constructed by integrating the equations of motion in the chamber space. Separate parts of the program may be used for calculations of various problems concerning the experimental data. (G.O.Y.)

6290 DOUBLE-AXIS CRYSTALLINE NEUTRON SPECTROMETER. Chikobava, V. S.; Doidzhashvili, G. I.; Abesadze, P. D.; Navasardov, S. A.; Sharabidze, T. I. (Inst. of Physics, Academy of Sciences, Georgian SSR). Prib. Tekh. Eksp., No. 4, 42-4(July-Aug. 1966). (In Russian).

A design is given of a double-axis crystalline neutron spectrometer for studying neutron inelastic scattering spectra. The device can be also used as a diffractometer. (tr-auth)

6291 AMPLIFICATION OF WEAK LINES OF CONVERSION-ELECTRON SPECTRA OBTAINED BY A β SPECTROGRAPH. Gromov, K. Ya.; Mukhtasimov, F. N.; Umarov, G. Ya. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 4, 39-41(July-Aug. 1966). (In Russian).

A method capable of amplifying about 15 times the weak lines of the conversion-electron spectra (which is equivalent to a 15 fold increase of spectrograph illumination) is described. It is assumed that further experiments would result in an even higher amplification factor. (tr-auth)

6292 ELECTRONIC DEVICE FOR MEASURING ELECTRON-BEAM AND γ-QUANTUM INTENSITIES. Arkatov, Yu. M.; Vatset, P. I.; Voloshchuk, V. I.; Kolesnikov, L. Ya.; Tonapetyan, S. G.; Chechetenko, V. F. (Inst. of Physics and Tech., Kharkov). Prib. Tekh. Eksp., No. 4, 95-7(July-Aug. 1966). (In Russian).

Electron beam and γ-quantum intensities were measured using an electronic device and the method of time-amplitude transformation. The device operates with a linear electron accelerator working at 50 Hz or at single accelerator pulses. (tr-auth)

6293 MULTICHANNEL HIGH-SPEED SEMICONDUCTOR DEVICES FOR EXPERIMENTS IN PHYSICS USING 10 GeV SYNCHROPHASOTRON. Zelenov, B. A.; Lebedeva, L. K.; Mantsa, I.; Moroz, N. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 4, 71-8(July-Aug. 1966). (In Russian).

A multichannel nanosecond semiconductor device acting as a data unit for Cherenkov and scintillation detectors was used in the experiments with charged particle beam in a 10-GeV synchrophasotron. The highly sensitive device permits recording of the pulses produced by one photoelectron in a cathode by means of the Cherenkov gas counter with FEU-36. The high precision of the device allows one reading in the channel of the secondary coincidence scheme per 10^6 readings in the channel of the primary scheme of coincidences at a load of 10^8 particles per sec. Seventeen counters can be used with easy switchover during the operation. (tr-auth)

6294 HIGH-SPEED CORRELATION COUNTER OF VISIBLE SPECTRUM PHOTONS. Artem'ev, V. V.; Gus'kov, L. N.; Mikhailov, V. N. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Prib. Tekh. Eksp., No. 4, 68-71(July-Aug. 1966). (In Russian).

Descriptions are given of a photon counter designed for correlation of photons in coherent light fluxes and operating at a range up to 6×10^{-10} sec. The operation of the counter in some mercury studies is discussed. The counter threshold sensitivity is 2×10^{-16} W. (tr-auth)

6295 PULSE GENERATOR FOR TIME ANALYZER. Kotov, B. A. (Inst. of Semiconductors, Leningrad). Prib. Tekh. Eksp., No. 4, 104-6(July-Aug. 1966). (In Russian).

A pulse generator is described which has been used in a time analyzer; the latter has been employed in experiments with inelastic scattering of slow neutrons. The unit comprises a slave oscillator with a delayed feedback and a regenerative RC-bridge-type frequency divider; the latter has a short recovery time and a high division stability. The repetition period is adjustable within 8 to 80 μsec, in steps of 8 μsec. The frequency stability is better than 0.1% within 10 to 30C (a drift under 0.1% in 5 hrs was observed). (ATD)

6296 HODOSCOPE SCHEME FOR GEIGER–MUELLER COUNTERS. Asatiani, T. L.; Matevosyan, E. M.; Sharkhatunyan, R. O. Prib. Tekh. Eksp., No. 4, 201-2(July-Aug. 1966). (In Russian).

A scheme based on the principle of pulse selection in a crystalline diode was developed for hodoscope control and counter pulse selection. A blocking generator with a cathode outlet was used for pulse selection. For the ≈900 V MC-9 counter the hodoscope MTX-90 tube operating a glow discharge was ignited, according to the control anode, by selective pulses from counters with >6 V amplitude. The resolving time of the hodoscope depends on the selective pulse duration and was in this case 1 to 2 μsec. The second hodoscope scheme with a triode amplifier was designed with selective pulse amplification and the MTX-90 tube ignition performed by the cathode with high amplitude negative pulses. With a large number of counters (~300) and continuous operation the hodoscope stability and efficiency was close to 100%. (R.V.J.)

6297 HIGH-SPEED THREE-STAGE VALVE OF 2 METER LIQUID HYDROGEN BUBBLE CHAMBER. Gerber, G. B.; Shkarlet, V. D. (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp., No. 4, 199-200(July-Aug. 1966). (In Russian).

A three-stage valve for a two-meter liquid hydrogen bubble chamber is described. The valve can discharge or feed air under pressures of 60 atmospheres with a transfer aperture of ϕ 70 mm and a closing time of two msec. (G.O.Y.)

6298 LARGE-AREA CHERENKOV COUNTER. Nymmik, R. A. (Inst. of Physics and Astronomy, USSR). Prib. Tekh. Eksp., No. 4, 59-62(July-Aug. 1966). (In Russian).

The results are reported of experiments with a Čerenkov counter which had a plexiglas radiator 580 mm in diameter and 46 mm in height. A photomultiplier placed in the center of the disk fed pulses to a preamplifier which, in turn, fed them, via a delay (5×10^{-7} sec) line, to an AI-100 differential height analyzer. The analyzer input was opened for 4 μ sec by a coincidence circuit whenever a charged particle passed the Geiger-counter telescope. This unit permitted isolating the signal from the photomultiplier noise and exploring the uniformity of sensitivity of the counter; three methods were tested: 1) total internal reflection of the Čerenkov light; 2) diffuse scintillator (coated with MgO or white paint); 3) combined radiator with total reflection in the center and diffuse reflector around the periphery. The third method exhibited the most uniform sensitivity: the maximum (50% higher than the average) photon area occupied 10% or less of the entire counter area. An output photomultiplier pulse of 17 photoelectrons was finally attained. (ATD)

6299 SHARK DETECTOR SHOWER PARTICLE RECORDING EFFICIENCY. Bolotov, V. N.; Devishev, M. I.; Knyazev, V. M. Tr. Fiz. Inst., Akad. Nauk SSSR. 34: 202-5(1966). (In Russian).

A method is proposed for determining the efficiency of a spark detector for recording each particle in a particle flux passing through the detector. (D.C.W.)

6300 LITHIUM FLUORIDE THERMOLUMINESCENT RESPONSES TO NEUTRONS. Weng, P. S. (Texas A and M Univ., College Station). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 222-8(Dec. 1966).

Two different types of commercial lithium fluoride phosphors in powder form, Con-Rad type N and type 7, were systematically studied according to their reactions with different neutron energies which range from thermal to 14 MeV. Special efforts were made to investigate the half life of isothermal decay, the order of kinetics, frequency factor, trap depth, probability factor, and the dosimetry prospect. The study of kinetics of thermoluminescent decay is based on the first-order and second-order kinetics and also on the experiments of isothermal decay and the glow curve analysis from which the parameters such as the frequency factor, s; the trap depth, E; the probability factor, and p_i, are derived. Comparison is made with the work of other investigators who have derived methods to determine the values of E and s. The experimental results show that type-N LiF has a relatively deep trap distribution, while type-7 LiF has a rather shallow trap distribution. This indicates that the order of kinetics for type-N LiF seems to be second order while that for type-7 LiF is most likely first order. Type-N LiF has a cross section of 71 barns for thermal neutrons. Through the reaction $^6Li(n,\alpha)^3H$, type-N LiF can be applied in thermal neutron dosimetry. Following Cameron's mathematical model, a definite relation between neutron fluence and thermoluminescence response was obtained. Type-7 LiF is a prospective material for fast neutron dosimetry. The collective experimental data throughout this investigation show that the thermoluminescent response of type-7 LiF subjected to neutron radiation is a function of neutron energy. (auth)

6301 EFFECT OF X-RAY RADIATION ON THE RESOLVING POWER OF AN NaI(Tl) SCINTILLATOR. Zakharko, Ya. M.; Chepelev, V. V. (Frank Lvov State Univ.). Ukr. Fiz. Zh., 11: 538-9(1966). (In Ukrainian).

Experiments were carried out to determine the cause of the decrease in resolution of γ spectrometers possessing thallium-activated NaI crystals, after exposure to hard x radiation. The 30-mm diameter and 5-mm thick crystals were irradiated at a dose rate of 300 to 350 R/minute for periods up to 60 minutes, measuring the resolution on a scintillation spectrometer a few hours after the exposure, when the phosphorescence was completely stopped. The specific resolution of the crystal was determined on the basis of the 662-keV γ line of ^{137}Cs. After 60 minutes of exposure, the resolution was found to be 40 to 45% lower while the amplitude of the photopeak was about 15% below the original value. This behavior is attributed to radiation-induced inhomogeneities in the crystal; this agrees with previous findings that the resolution depends on scintillation efficiency which is a function of the distribution of the activators in the crystal. (TTT)

6302 FLOOR MONITOR FOR ALPHA CONTAMINATION (Engineering Materials). (North American Aviation, Inc., Downey, Calif.). (CAPE-1512).

14 drawings.

Large proportional counters measure α contamination on floors faster and more conveniently than portable instruments. The counter is mounted on a 4-wheel carriage with a waist-high handle. A 4½ in. visual readout and an audible alarm are employed. A blocking oscillator and voltage quadrupler circuit develop the 2400 V required for the counter. (For details see TID-4100 Suppl. 38.) (F.S.)

6303 RADIATION DETECTORS. Pringle, R. W.; Roulston, K. I.; Brownell, G. M. Canadian Patent 745,708. Nov. 1, 1966.

A portable meter is described especially designed for detecting radiation from minerals, liquids, and gases. Sensitivity of 10^{-10} roentgens per second makes it useful for aerial prospecting. The energy as well as the intensity of gamma radiation may be measured. Operation depends on the scintillation of certain crystals such as sodium iodide activated with thallium, when bombarded by gamma rays. Means for lengthening and amplifying small pulses are detailed. In another embodiment the meter serves as a neutron spectrometer. Electrons can also be detected. (F.S.A.)

Radiation Dosimeters

Refer also to abstracts 5903, 5961, 6207, 6231, and 6564.

6304 (AERE-M-1778) IRON AS A FAST-NEUTRON MONITOR. Carter, P. (Atomic Energy Research Establishment, Harwell (England)). Oct. 1966. 22p. Dep. BIS $0.70, HMSO 3s. 6d.

The techniques adopted at A.E.R.E., Harwell for the use of the $^{54}Fe(n, p)^{54}Mn$ reaction in natural iron as a long-term fast-neutron monitor are described. The additional $^{58}Fe(n,\gamma)^{59}Fe$ thermal-neutron reaction may be used in shorter irradiations for obtaining thermal-neutron doses. Since large numbers of monitors are required the monitors are chosen to be in the form of wires, weighing 1.6 mg. The activities of the ^{54}Mn and ^{59}Fe components present in the irradiated monitors are measured, without recourse to chemical separation, by means of a gamma-ray scintillation spectrometer fitted with a gain-stabilization system to enable reliable comparison of spectra. The activities are determined with respect to standard sources of ^{54}Mn and ^{59}Fe. The nuclear data used for the analysis of the $^{54}Fe(n,p)^{54}Mn$ reaction is an activation cross section of 78 mb and a 313.5-day half-life for the ^{54}Mn nuclide, and for the $^{58}Fe(n,\gamma)^{59}Fe$ reaction a 2200 m s^{-1} cross section of 1.09 barns and a 45.1-day half-life. Relative flux measurements can be made to within ±1%. Absolute flux values cannot be determined within ±3% in the case of the fast-neutron flux and ±4% for the thermal-neutron flux, the chief causes of error being in the value for the integral cross section and absolute activity measurements. (auth)

6305 (COO-1226-12) DEVELOPMENT OF A FAST NEUTRON DOSIMETRY SYSTEM. Final Report. Chase, B. H.; Closser, W. H.; Speers, R. R.; Swartz, J. M.; Thurston, M. O. (Phylatron Corp., Columbus, Ohio). Oct. 1, 1966. Contract AT(11-1)-1226. 53p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The various aspects of a program for the development of a highly sensitive fast neutron dosimetry system are discussed. Topics included are processing studies, dosimeter irradiation behavior, Pu-Be source irradiations, room temperature annealing, badge design requirements, base width dosimeter, extended range of dosimeter, surface leakage, and reader for dosimeter. (B.G.D.)

6306 (UCRL-70171) PERSONNEL MONITORING WITH FILM, GLASS, AND TLD. Kathren, R. L.; Yoder, R. E. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 7, 1966. Contract W-7405-eng-48. 8p. (CONF-661027-1). Dep. mn. CFSTI $3.00 cy, $0.650 mn.

From Western Industrial Health Conference, Los Angeles, Calif.

Criteria for the ideal personnel dosimeter are presented. It is concluded that no dosimeter in present use fills all the requirements. The performance of photographic film dosimeters, radiophotoluminescent glass dosimeters, and thermoluminescent dosimeters is discussed. It is concluded that radiophotoluminescent glass and thermoluminescent dosimeters are both superior to photographic film dosimeters and that the ideal personnel dosimeter should include all three radiation detectors. (C.H.)

6307 EXPERIENCE GAINED IN OPERATING A DOSEMETER CALIBRATION FACILITY. Clarke, R. W.; Lavender, A.; Thompson, I. M. G. (Central Electricity Generating Board, Berkeley, Eng.). Health Phys., 13: 73-82(Jan. 1967).

Operational experience in the Dosemeter Calibration Facility at the Berkeley Nuclear Laboratories of the Central Electricity Generating Board shows that the main equipment, a 400 keV posi-

tive ion accelerator and a 250 kV x-ray set, has proved adequate for the accurate calibration of health physics dosemeters. The sealed sources employed on the facility are satisfactory for routine calibration purposes but could be more closely correlated to the national standards used for bremsstrahlung beams. (auth)

6308 EARLY FADING OF THERMOLUMINESCENCE INDUCED BY RADIATION IN LITHIUM FLUORIDE. Anderson, J. A.; Feldman, A.; Williams, M. M. D. (Mayo Foundation, Rochester, Minn.). Nature, 213: 61-2(Jan. 7, 1967).

It is stated that little attention has been paid to fading which may occur during the first 24 hours after irradiation. Knowledge of, or elimination of, early fading is important when it is desired to read out, with a precision of a few per cent, a group of samples soon after irradiation. A typical fading curve is shown for a powder which had been exposed to a standard annealing of 1 hour at 400°C plus 24 hours at 80°C before use. It is clear that if the readout of a sizable series of samples irradiated simultaneously is begun soon after irradiation, the fading can be more than a few per cent by the time the final sample is read out. It is shown, by recording glow curves, that early fading is caused principally by decay of the low temperature peaks described by Zimmerman, who also found that the low temperature peaks are not present if the powder is annealed for 10 min at 100°C after irradiation. Another method used to avoid the effects of early fading is to program the readout cycle so that the phototube current circuit is held open until the low temperature peaks have been passed. Two other methods are to incorporate a short annealing at 100°C as the first part of the readout cycle, and to correct the readings on the basis of a fading curve for the same batch of LiF powder. (UK)

6309 PULSED ELECTRON BEAM DOSIMETRY. Oswald, R. B. Jr.; Eisen, H. A.; Conrad, E. E. (Harry Diamond Labs., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 229-36(Dec. 1966).

The use of pulsed electron sources capable of delivering doses of tens of megarads in periods of 10 to 40 nanoseconds presents unique problems from the standpoint of dosimetry. To conduct experiments in this environment it is usually desirable to measure the spatial variation of the incident flux as well as the absorbed dose. The larger available pulsed electron machines may give poor exposure reproducibility at constant source-to-sample distance. This requires that dosimetry be performed with each exposure and necessitates the use of a "thin" in-line dosimeter. Measurements of absorbed dose are readily obtained by "thin calorimeter" techniques. A practical limitation to this type of measurement is its insensitivity to point variations in the incident flux. Changes in transmittance, or optical density, of materials such as blue cellophane or red Cinemoid provide a means of mapping the exposure with reasonable precision. Comparative dosimetric studies were made with titanium, aluminum, and copper calorimeters with thickness as a variable. An in-line pair calorimeter can be used to measure the surface dose to a sample provided the effects of scattering (including back-scattering) and absorption are considered. The change in transmission of the dyed films for a given amount of energy absorbed showed a strong dependence on the ambient oxygen concentration. The oxidation effect is obvious when one compares pulsed and steady-state irradiation in air and in vacuum. Therefore, ambient conditions must be considered in a calibration. Examples of spatial variations in energy flux are presented in the form of isodose lines obtained by isodensity readings on exposed blue cellophane. (auth)

6310 DYNAMIC PROBE CRYOSTAT (Engineering Materials). (Argonne National Lab., Ill.). (CAPE-1500).

58 drawings.

A cryostat system is used with a calorimeter to make γ and neutron absorbed dose measurements at various radiation facilities. The calorimeter can be placed within an inch of an external radiation source to make dose measurements from the monoenergetic neutron beams produced by the $^{7}Li(p,n)^{7}Be$ reaction in a Van de Graaff accelerator and since it operates in a horizontal plane, it may be used as a probe in a cyclotron radiation beam port. A carbon calorimeter may be used or a tissue-equivalent calorimeter may be used for γ-ray and neutron measurements. (For details see TID-4100 Suppl. 37.) (F.S.)

6311 CHEMICAL DOSIMETRY OF IONIZING RADIATION. Broszkiewicz, R. K. (Inst. of Nuclear Research, Warsaw). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-78/2, 44p. (CONF-661005-9). DTIE.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna.

Chemical dosimeters are discussed in some detail, and the discussion is limited to water and aqueous solutions, pure organic substances and organic solutions, monomers and polymers, and organic and inorganic gases. Particular emphasis is given to the Fricke dosimeter and to some modifications of it. A special discussion of methods and problems involved in obtaining water pure enough to be satisfactory for use in dosimeters is presented. One hundred and five references are cited in the paper. (B.L.M.)

6312 CERIC AND FERROUS DOSIMETERS FOR THE 50 TO 1500 RAD RANGE. Frigerio, Norman A.; Henry, Victor D. (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-78/12, 14p. (CONF-661005-14). DTIE.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna.

The addition of ammonium thiocyanate to ferrous sulfate dosimeter solution, irradiated and handled in the usual way, afforded an eight-fold increase in sensitivity. This two-fold increase over previous thiocyanate methods resulted chiefly from the increased SCN^- concentration obtainable with ammonium salt. This increased concentration operated, also, to diminish temperature sensitivity while the high concentration of NH_4^+ decreased the rate of ferrous ion autoxidation by complexing the latter. Two methods were used successfully, both employing visible-region colorimeters at 475 mμ for determination of the ferric thiocyanate complex. In the first, one volume of a saturated aqueous solution of ammonium thiocyanate was added to three volumes of irradiated dosimeter. In the second, dosimeter was added to a known mass of solid ammonium thiocyanate; this method was $^4/_3$ as sensitive as the other because of the absence of dilution. Absorbance was strictly proportional to ferric ion concentration, with $\epsilon_{475} = 17{,}600$ liter mole^{-1} cm^{-1}, from A = 0 to A = 1.0. No temperature effect was found between 20 to 25°C, and no time effect between 5 and 25 minutes after mixing. In a 10-cm cuvette 50 RADs gave A = 0.144 ± 0.01. In order to render the ceric dosimeter, whose response is independent of LET of irradiation, sufficiently sensitive for mammalian radiobiology, advantage was taken of the fact that the fluorescence of fluorescein is quantitatively destroyed by ceric oxidation under the usual conditions of ceric dosimetry. Fluorescence of one volume of 5×10^{-5} M aqueous fluorescein added to 12.5 volumes of irradiated ceric dosimeter was found to be a simple, quasi-linear function of dose over the range from 50 to 1500 RAD with a precision of ±1% and no observable temperature or time dependence between 20 and 35°C and 10 to 100 minutes. Techniques developed and curves obtained with 250 kVp x rays, ^{60}Co gamma rays, and monoenergetic neutrons are presented. (auth)

6313 AERATED SYSTEMS OF THE TYPE RH-RCl_x-ETHANOL-THYMOLSULPHONPHTHALEIN-STABLE LOW-LEVEL CHEMICAL DOSIMETERS. Dvornik, I.; Zec, U.; Ranogajec, F. (Inst. Ruder Boskovic, Zagreb). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-78/15, 14p. (CONF-661005-13). DTIE.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna.

The characteristic of dosimeters described is the very sensitive colorimetric method of dose evaluation giving a fair sensitivity with low G(HCl). In addition, the systems are thermally stable and simple to manufacture. With photocolorimetric or spectrophotometric evaluation of about 100 RAD the dosimetric error is about one RAD or lower. The examined technique of visual colorimetric evaluation at the same dose level gives a combined error of 10 to 20 RAD, and up to ±5 or 10% at 500 RAD. Because of the practically unlimited shelf life of dosimeters and visual colorimeters and the very low production costs of both devices, such chemical dosimeters could be of special interest for massive use as personal γ dosimeters for wide populations or as dosimeters for γ and fast neutron dosimetric topography of nuclear accidents. With tetrachloroethylene and isooctane G(HCl) was found constant (8.4) for temperatures between -10 and +35°C and for dose rates between 80 and 80,000 RAD per hour. The upper dose limit of colorimetric evaluation is about 2000 RAD. With other components G(HCl) can be lower and the range extends to higher doses. The colorimetric properties of the systems RH - ethanol - thymolsulphonphthalein as well as some of the most interesting features of the production procedure are described. The radiation-chemical aspects are discussed briefly. (auth)

6314 GAMMA DOSIMETRY BASED ON THE POLYMERIZATION OF METHACRYLONITRILE AND SUBSEQUENT DETERMINATION OF THE KETENIMINE ABSORPTION AT 4.96 μ. Talat-Erben, M.; Unseren, Envare; Seber, Nurten (Cekmece Nuclear Research Center, Istanbul). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-78/18, 12p. (CONF-661005-21). DTIE.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna.

Gamma-initiated polymerization of methacrylonitrile produces ketenimine linkages (> C = C = N-), which have a characteristic

absorption band at 4.96 μ. The optical density at this wavelength of the irradiated monomer increases almost linearly with the gamma dose up to 30% conversion. The ketenimine group is surprisingly stable under gamma irradiation, and post-effects are absent. Exposure to radiation and subsequent measurement of the optical density (or transmittance) at this specific wavelength makes it possible to determine doses up to about 18 MRAD, without dilution of the sample. Still higher doses can be determined if the sample is diluted with unirradiated monomer before spectrophotometry. Methacrylonitrile seems superior to other polymerization dosimeters on the grounds that separation and quantitative determination of the polymer formed are unnecessary, and that errors and difficulties usually associated with such operations do not occur. The same system can be used for determining several doses cumulatively, if the total dose accumulated does not exceed 18 MRAD (without dilution). (auth)

6315 PHOSPHATE GLASS FOR DOSIMETRY. Carpentier, S.; Bedier, R.; Francois, H.; Grand-Clement, Anne-Marie; Meneret, J. (to Commissariat a l'Energie Atomique). Canadian Patent 745,205. Oct. 25, 1966. Priority dates Mar. 23, 1962 and Mar. 1, 1963, France.

An improved glass for dosimetry of x- and gamma radiation uses silver oxide as an activator in addition to the usual glass components. Composition of the glass is given and greater sensitivity is claimed. (F.S.A.)

Radiometric Instruments

6316 (AEC-tr-6466/2) THE USES OF RADIOACTIVE ISOTOPES AND NUCLEAR RADIATION IN THE U.S.S.R. PROCEEDINGS OF ALL-UNION CONFERENCE HELD IN RIGA, 12–16 APRIL 1960. VOLUME TWO. CONSTRUCTION AND BUILDING-MATERIALS INDUSTRY LIGHT INDUSTRY FOOD INDUSTRY AND AGRICULTURE MEDICINE. Petrov, N. A.; Petrenko, L. I.; Savitskii, P. S. (eds.). Translated from Radioakt. Izotopy i Yadernye Izlucheniya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., Riga, 1960, 2: (1961). 273p. (IPST-Cat.-1242; CONF-600402(Vol.2)). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The current status and prospects for future application of radioisotopes and nuclear radiations in the U.S.S.R. are reported. Topics discussed are the application of radioisotopes and nuclear radiations to the solution of industrial problems in the construction and building materials industry, light industry, food industry, agriculture, and medicine. (R.C.K.)

6317 (AEC-tr-6466/3) THE USES OF RADIOACTIVE ISOTOPES AND NUCLEAR RADIATION IN THE U.S.S.R. PROCEEDINGS OF ALL-UNION CONFERENCE HELD IN RIGA, 12–16 APRIL 1960. VOLUME THREE. MACHINE BUILDING AND METALLURGY. Rumyantsev, S. V.; Tsepaev, V. A.; Gruzin, P. L.; Lebedev, A. K.; Gerasimchuk, G. S. (eds.). Translated from Radioakt. Izotopy i Yadernye Izlucheniya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., Riga, 1960, 3: (1961). 229p. (IPST-Cat.-1243; CONF-600402(Vol.3)). Dep. mn. CFSTI $6.00 cy, $1.25 mn.

The current state and prospects of the application of radioisotopes and nuclear radiation in machine building and in metallurgy are reported. In industry radioisotopes are reported being used in processing, quality control, and reliability testing of products from such areas as the automobile and engine industries, shipbuilding industry, and metallurgical and mining industries. The economics in using these methods, rather than the time consuming and often inaccurate conventional methods, are outlined. Other topics discussed are radiation sources, radiation detectors, and density, level and thickness gages. (B.G.D.)

6318 (AEC-tr-6466/4) THE USES OF RADIOACTIVE ISOTOPES AND NUCLEAR RADIATION IN THE U.S.S.R. PROCEEDINGS OF ALL-UNION CONFERENCE HELD IN RIGA, 12–16 APRIL 1960. VOLUME FOUR. SEARCH, PROSPECTING, AND EXPLOITATION OF MINERAL RESOURCES. Petrenko, L. I.; Savitskii, P. S.; Speranskii, M. A. (eds.). Translated from Radioakt. Izotopy i Yadernye Izlucheniya v Nar. Khoz. SSSR, Tr. Vses. Soveshch., Riga, 1960, 4: (1961). 320p. (IPST-Cat.-1244; CONF-600402(Vol.4)). Dep. mn. CFSTI $7.00 cy, $1.50 mn.

The current state and prospects of the application of radioisotopes and nuclear radiations for searching, prospecting, and exploitation of mineral resources in the U.S.S.R. are reported. Topics discussed are radiometric equipment and methods of well logging coal, gas, ore, and petroleum deposits; economic aspects of radiometric techniques, use of radioactive isotopes for geophysical purposes, and tracer techniques in geology. (B.G.D.)

6319 CORROSION MONITORING IN OIL WELLS WITH A RADIOACTIVE SPECIMEN. Gordon, B. E. (Shell Development Co., Emeryville, Calif.); Raifsnider, P. J.; Lilly, D. L. Mater. Protect., 5: 21-3(Nov. 1966).

A method was developed to continuously monitor corrosion of tubing in oil wells using a specimen of steel containing ^{60}Co and measuring the radioactivity in the produced fluid. Results showed that corrosion rates less than one mil/yr can be measured, that this radio-tracer method accurately reflects corrosion of the tubing, and that the method can be used to observe the effects of different corrosion inhibition treatments. The sensitivity of such a monitor can be adjusted to almost any desired level by changing the level of radioactivity in the specimen and the method of counting. The radioactive monitor makes it possible to measure corrosion rates continuously under all operating conditions. In tests to evaluate the effectiveness of different inhibition treatments, dump bailer treatments using diamine salt were ineffective, but jet-stream application with imidazoline additive was effective. It was also demonstrated that there is quantitative agreement between the integrated corrosion of the test specimen using radioactivity data and as measured by caliper surveys. (BBB)

6320 SIDEWALL EPITHERMAL NEUTRON POROSITY LOG. Tittman, J.; Sherman, H.; Nagel, W. A.; Alger, R. P. (Schlumberger Well Services, Ridgefield, Conn.). J. Petrol. Technol., 18: 1351-62(Oct. 1966).

A sidewall epithermal neutron system was developed to reduce environmental effects that complicated neutron log interpretation. Designed for operation in uncased wells, the device provides increased accuracy in both liquid-filled and empty holes. Discussion of neutron moderation, diffusion, and capture showed that logs using epithermal neutron detection depend on a smaller number of formation-characterizing parameters than those using thermal neutron or capture γ-ray detection. Thus, they come closer to providing an unambiguous determination of H content. In this new device, a directionally sensitive epithermal neutron detection system was incorporated in a side-wall source-detector skid to minimize borehold effects. The effects of variations in borehold size and shape, mud type, temperature, and salinity are greatly reduced. Small residual borehole effects are computationally accounted for in the surface control panel to provide a borehold-corrected neutron log. Comparison with a linear porosity presentation of a formation density log permits sandstones, limestones, and dolomites to be readily identified. Thus, in complex or variable lithology, porosity is determined with greater accuracy and reliability. Laboratory data and field results are presented to demonstrate the improvements in neutron logging. (BBB)

6321 MEASURING ELECTRODEPOSIT THICKNESS: A BETA BACKSCATTER METHOD FOR THE PLATINUM METALS. Platinum Metals Rev., 11: 13-14(Jan. 1967).

In the electrodeposition of the platinum group metals it is important that thicknesses are accurately known. There is need for a process control technique capable of checking electrodeposit thicknesses rapidly and nondestructively. The conventional methods of measuring thicknesses are inaccurate and time consuming. A commercial type (Johnson Matthey) beta backscatter thickness gauge was developed and is briefly described. The isotope employed is ^{85}Kr. (UK)

6322 MULTIPLE-PURPOSE ALPHA PARTICLE THICKNESS GAGE. Tatcher, M. (Israel Inst. of Tech., Haifa). Nucl. Instrum. Methods, 46: 171-2(1967).

A device is described in which monoenergetic alpha particles are detected by a semiconductor detector in a vacuum chamber. The energy lost in a foil inserted between the foil and detector introduces a shift in the position of the alpha energy spectrum observed with a pulse height analyzer. The foil thickness may then be found with the aid of energy loss data. (B.G.D.)

6323 INFLUENCE OF BULK DENSITY OF THE SOIL ON NEUTRON MOISTURE METER CALIBRATION. Holmes, J. W. (CSIRO, Adelaide). Soil Sci., 102: 355-60(Dec. 1966).

A method is described for calibrating a neutron moisture meter by including all the hydrogen content of the soil and expressing it as equivalent water content by volume (θ), and by adjusting the observed counting rate (n_1) to a value (n_2), which it would have in a soil possessing the macroscopic cross section for absorption of slow neutrons of the undisturbed soil. However, the improvement is so slight that the adjustments described would be worth making only when it is desired to push to the limit the resolution of the method for distinguishing change in water content. Also, there seems to be no alternative to individual calibration of each soil intended for investigations. (P.C.H.)

6324 MATHEMATICAL MODELING STUDY OF THE GAMMA-RAY SCATTERING TECHNIQUE FOR MEASURING ATMOSPHERIC DENSITY. Gardner, R. P.; Whitaker, D. R. (Research Triangle Inst., Durham, N. C.). Trans. Amer. Nucl. Soc., 9: 601(Oct.-Nov. 1966).

6325 MEASUREMENTS WITH NEUTRONS. A FURTHER AREA OF APPLICATION IN MOISTURE DETERMINATION AND ACTIVATION ANALYSIS. Kosmowski, A. (Frieseke und Hoepfner GmbH, Erlangen-Bruck, Ger.). VDI (Ver. Deut. Ing.) Nachr., 19: 7(Oct. 1965). (In German).

The fundamentals of theory and techniques of analysis by neutrons are reviewed. A method of analysis of ground water by neutron moderation is presented, with the use of a Ra-Be source which measures sample density by γ radiation and moisture content by neutron radiation; one device measures content at the surface; a deep sound measures water content at depths to 20 m. Each sound consists of a neutron counter coupled directly to a 10-mCi Ra-Be source for deep samples, or a 2-mCi source for surface measurements. Results are obtained directly with precision of 1% in a nondestructive fashion. Several applications of the technique are suggested. Activation analysis is briefly described and compared in sensitivity with standard chemical methods. Problems of sources for such studies and the sensitivity of the method for different elements are discussed. Several areas for application are listed. Illustrations of the apparatus for ground density and moisture content are given. (BBB)

Miscellaneous Instruments and Components

Refer also to abstracts 6990, 7076, and 7089.

6326 (CEA-R-3055) ESSAIS DE PROTOTYPES DE JAUGES A VIDE POUVANT TRAVAILLER EN ATMOSPHERE CORROSIVE (FLUOREE). (Trials Carried Out on Corrosive (Fluorinated) Atmosphere Vacuum Gages). Constant, Madeleine; Houyvet, Alain; Noe, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1966. 11p. (In French). Dep. mn.

A study of the stability of readings given by a modified Pirani type measurement probe with a view to long term operation in the presence of corrosive gases is discussed. Results of measurements carried out before and after use under these conditions are presented. (auth)

6327 (CLM-R-64) OPTICAL TRANSMISSION DATA FOR THIN ALUMINIUM FILMS. Burton, W. M. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Aug. 1966. 8p. Dep. mn. BIS $0.20, HMSO 1s. 2d.

The variation of the linear absorption coefficient of aluminum with wavelength between 1 Å and 6500 Å is summarized, using published data. Calculated transmission curves for typical aluminum filters are obtained with allowance for the additional absorption in an oxide layer. A filter of thickness 1000 Å gives a useful transmission waveband at wavelengths below 80 Å and also between 170 Å and 700 Å, but is almost opaque (density ≃ 6) at visible wavelengths. A simple method is described for estimating the thickness of aluminum filters by measurements of the optical transmission in white light. (auth)

6328 (GEAP-5166) AN OUT-OF-PILE EVALUATION OF W-Re THERMOCOUPLE SYSTEMS FOR USE TO 4700 DEG F IN PuO_2-UO_2. Novak, P. E.; Asamoto, R. R. (General Electric Co., San Jose, Calif. Advanced Products Operstion). June 1966. Contract AT(04-3)-540. 60p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An out-of-pile investigation was made to determine the characteristics of W3Re/W25Re and W5Re/W26Re thermocouple systems, for use in measuring fuel temperatures under SEFOR conditions. Bare-wire tungsten-rhenium thermocouples were calibrated to temperatures above 5400°F (3000°C) in vacuum. Drift tests for 15 hours at 4700°F (2600°C) indicated good stability. The performance of thoria-insulated thermocouples was observed to be adequate and reproducible for temperature measurements to 5100°F (2800°C). Beryllia-insulated thermocouples performed satisfactorily up to 4600°F (2550°C) for short periods of time. Tungsten-26 percent rhenium thermocouple sheathing and mixed oxide fuel (17% PuO_2-83% UO_2) were compatible at average SEFOR fuel temperatures, but showed signs of reaction at 4700°F (2600°C). (auth)

6329 (HW-39535) SLIT CAMERA FOR CYLINDRICAL SURFACE. Reynolds, R. L. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 15, 1966. Contract AT(45-1)-1350. 6p. DTIE.

A mock-up camera was constructed to evaluate the usefulness of the slit camera principle for reactor fuel element photographs. (B.G.D.)

6330 (IA-1082, pp 289-94) INSTRUMENTATION. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

Two new types of electrostatic analyzers are described. A neutron scattering chamber is also described which will be used in neutron capture gamma ray spectroscopy. (B.G.D.)

6331 (IA-1082, pp 295-309) ELECTRONICS. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

The design and construction of various electronic equipment are discussed. These were: a low charge sensitive amplifier, fast timing circuits using storage diodes, a fast counter, nucleonic modules, time-to-amplitude converter, spectrum stabilizer, a waveform generator for a mass spectrometer, an upper audio-frequency heat supply for a mass spectrometer, a linear heating system for crystals, a parity checking device for a 3 dimensional multichannel analyzer, a capacitance bridge for semiconductor detectors, a portable linear ratemeter, a fast solid-state light pulser, instrumentation for a pulsed nuclear magnetic resonance system, and an air particle monitoring system. (B.G.D.)

6332 (JINR-P9-3014) YAMR DISKRIMINATOR MAGNITONOGO POLYA I AVTOMATIZATSIYA RABOTY MAGNITOMETRA. (NMR Magnetic Field Discriminator and Automatization of Magnetometer Operation). Lachinov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 18p. (In Russian). Dep. mn.

The NMR discriminator of the magnetic field with the modulation amplitude, which exceeds the NMR width of a line, is described. A scheme is presented in which the discriminator is used to realize locking of the magnetometer to the measured field with an accuracy better than 10^{-5}. A possibility of complete magnetometer automatization in each of its subbands is considered. (auth)

6333 (JUL-290-PP) DIE ENTWICKLUNG EINER KURZZEITKAMERA HOHER AUFLOESUNG MIT DEM IMAGE-ORTHIKON. (Development of a Short-Time Camera of High Resolution with the Orthikon Image). Hopmann, W. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). Aug. 1966. 73p. (In German). Dep. mn.

The development of a high speed still camera is described, which uses the Image Section of an Image-Orthicon Television Camera Tube as high speed photoelectronic shutter. The general problems of using TV-apparatus in high speed photography are discussed. A commercially manufactured closed circuit TV-system was modified for single frame scanning. These modifications and the auxiliary circuits are described. The effects of high electron currents in the image section at very short exposure times are estimated and compared with experimental results. The shutter efficiency of the image section is mainly determined by photoelectric emission of the target foil, the reasons of that emission are discussed. (auth)

6334 (N-66-28024) DEVELOPMENT OF A STABLE ULTRAVIOLET SOURCE AND TECHNIQUES FOR ACCURATE RADIOMETRY. Annual Summary Report, January 1-December 31, 1965. Kostkowski, Henry J.; Yokley, Charles R.; Erminy, Diamond E.; Hattenburg, Albert T. (National Bureau of Standards, Washington, D. C.). 1966. 98p. (NASA-CR-75552; NBS-9099). CFSTI $3.00 cy, $0.65 mn.

The characteristics of a small portable model of a high pressure plasma arc source and its associated equipment are described along with detailed drawings of some of its critical mechanical and electrical components. The philosophy, approach, results, and limitations of high accuracy spectral radiance calibrations of tungsten strip lamps are discussed. Results obtained from a determination of the low current graphite arc spectral radiance from 8500 to 2100 Å using a high accuracy spectroradiometer are described. (STAR)

6335 CORRELATION BETWEEN SUCCESSIVE COUNTINGS AT THE OUTPUT OF A NUMERICAL DIVIDER OPERATED BY IMPULSES WITH A POISSON DISTRIBUTION. Freycenon, J. (CEN, Saclay, France). Onde Elec., 1231-6(Nov. 1966).

The probability distribution in time of impulses issuing from a scaler acting as a numerical divider, is studied when the input consists of impulses with a Poisson distribution. The variance of a single counting is computed. It is shown that, generally, if the number of incoming pulses is larger than 10 times the square of the capacity of the divider no information is practically lost by counting the events after division. The correlation between successive countings is determined. It is shown that the divider acts like a multiple band pass filter for the instantaneous counting rate of the Poisson distribution. The results are applied to oscillations experiments on a reactor. (auth)

6336 INSTABILITY OF REFRACTORY METAL THERMOCOUPLES. Walker, B. E. Jr.; Ewing, C. T.; Miller, R. R. (Naval Research Lab., Washington, D. C.). pp VII.D.1-24 of

Proceedings of the 4th Conference on Thermal Conductivity. San Francisco, U. S. Naval Radiological Defense Lab., 1964.

Thermoelectric instabilities of some refractory metal thermocouples were studied in the temperature range from 1000 to 2000°C under vacuum and neutral atmospheres. The sources of instability were found to be complex, involving contamination from ceramic protection tubes and furnace environments, preferential volatilization, and various thermal anomalies such as recrystallization and phase changes in the refractory thermoelements. Refractory thermocouples and thermoelements were studied under a variety of conditions and emf changes associated with each are reported. Recommendations are presented for the selection and application of these thermocouples to attain maximum thermoelectric stability. (auth)

6337 LOW NOISE, HIGH INPUT IMPEDANCE, NANOSECOND PULSE AMPLIFIER. Goyot, M.; Samueli, J.-J.; Sarazin, A. (Univ., Lyon). Nucl. Instrum. Methods, 46: 149-52(1967).

An impedance matching circuit providing an unity gain with an input impedance of 7 pF in parallel with 10 MΩ and a rise time (for low driving impedance) of 0.7 ns is described. An amplifier, with a gain of 10 and a rise time of 1.0 ns for an input and load impedance of 50 Ω is also discussed. (auth)

6338 PULSE SHAPING CIRCUIT WITH ZERO RECOVERY TIME. Van Zurk, R. (Centre d'Etudes Nucleaires, Grenoble, France). Nucl. Instrum. Methods, 46: 125-9(1967). (In French).

A pulse shaping circuit having zero recovery time is described. The width of the pulse is adjustable by means of a clipping line, in the range of 6 ns to about 500 ns. The minimal resolution time of the circuit is 10 ns. Another important feature is the fact that the duration of the output pulse is four times the delay of the line. (auth)

6339 DIGITAL TO ANALOG PULSER SYSTEM FOR TESTING PULSE HEIGHT ANALYZERS. Gardner, F. M. (Gardner Research Co., Reseda, Calif.); McKeethen, R. Nucl. Instrum. Methods, 46: 121-4(1967).

A method for linearity, both integral and differential, testing of pulse height analyzers is presented. A novel technique employing a digital to analog (D/A) converter approach to simplify testing of pulse height analyzers is discussed and a description of the construction and performance of a working model is presented. Illustrations are also presented which show test results of two (2) units. (auth)

6340 REVIEW OF BASIC ELECTRONIC INSTRUMENTATION FOR NUCLEAR PHYSICS. Guillon, H. (CEN, Saclay, France). Onde Elec., 1217-30(Nov. 1966). (In French).

The present state of the basic instrumentation techniques is investigated. Particular emphasis is stressed on analog data processing owing to its more specific aspect in nuclear techniques. The following items are reviewed: amplifiers, single-channel analyzers, linear gates, test instruments, and pulse height analyzers. (auth)

6341 PRODUCTION OF AN INTENSIVE PULSE OF WEAK X RADIATION. Ovechkin, V. Ya.; Generalov, N. A. (Moscow State Univ.). Prib. Tekh. Eksp., No. 5, 240-1(Sept.-Oct. 1966). (In Russian).

Construction of a special pulse x-ray tube designed for absorption of weak x rays by heavy gases (xenon, krypton, etc.) is described. The instrument is used for measuring the instantaneous density distribution in a given gas volume. The brass tube has an inside diameter of 76 mm, and a wall 7 mm thick. The tube is evacuated to 2×10^{-6} mm Hg using an RVN-20 forevacuum pump and a TsVL-100 diffusion pump. A 3-mm L-cathode of high emission ability is employed. The anode is made of tungsten and it can be moved vertically and horizontally, thus adjusting the direction of the x-ray beam, exiting the tube through a 0.2-mm beryllium window. The voltage pulse, fed to the x-ray tube, is formed by a voltage pulse generator consisting of two chambers which are described in detail. An FEU-12 photomultiplier with a scintillator serves as an acceptor of the x-rays. The signal produced is observed on an OK-17m oscilloscope. (ATD)

6342 GENERATOR OF TRIPLE ELECTRIC AND LIGHT PULSES OF NANOSECOND DURATION. Afanas'ev, N. G.; Denyak, V. M.; Startsev, V. I. (Inst. of Physics and Tech., Academy of Sciences, Ukrainain, SSR). Prib. Tekh. Eksp., No. 5, 229-30 (Sept.-Oct. 1966). (In Russian).

A design is given of a simple short ($\tau = 10^{-8}$ sec) triple electric and light pulse generator used for adjusting fast calculation circuits, coincidence circuits, and photomultiplier parameters. The generator is equipped with hydrogen dischargers. The pulse shifts are achieved by variable 0 to 0.5 μsec delay lines. The duration of the emerging electric pulses is 10 nsec, and for light pulses 50 nsec. (tr-auth)

6343 USE OF DIFFERENTIAL-THERMAL CALORIMETER FOR MEASURING ENERGY STORED BY IRRADIATED CRYSTALS. Zavadovskaya, E. K.; Kuz'mina, A. V.; Timoshenko, N. M.; Shishkin, I. S. (Tomsk Polytechnic Inst., USSR). Prib. Tekh. Eksp., No. 5, 215-17(Sept.-Oct. 1966). (In Russian).

The design of a calorimeter for differential-thermal analysis of ionic crystals is presented. The instrument is capable of measuring the thermal effect of not less than 0.5 J/g with an error of ±15% at room temperature to 600°C. Energy thermograms for energy storage of γ irradiated LiF crystals are included. (tr-auth)

6344 AUTOMATIC MICROCALORIMETER. Zavadovskaya, E. K.; Kuz'mina, A. V.; Golovchanskii, E. M. (Tomsk Polytechnic Inst., USSR). Prib. Tekh. Eksp., No. 5, 217-19(Sept.-Oct. 1966). (In Russian).

A description is given of an automatic Kalve type microcalorimeter for measuring the heat of formation of solid solutions, dissolution heat, and energy stored in irradiated alkali-halide crystals. The instrument has three sensitive maxima: 1.77×10^{-2}, 1.77×10^{-3}, and 1.77×10^{-4} J/cm² of the scale. The time constant of the microcalorimeter is 342 sec. The heat processes are recorded by a FEOU-18 photoelectro-optical amplifier with an electron EPP-09 potentiometer. (tr-auth)

6345 TIME-DELAY PARAMETERS OF PHOTOMULTIPLIERS OPERATING WITH LARGE PULSE CURRENT YIELD. Averchenkov, V. Ya.; Berkovskii, A. G.; Dukor, S. G.; Spekhov, Yu. A. (Moscow Tube Plant). Prib. Tekh. Eksp., No. 5, 189-91(Sept.-Oct. 1966). (In Russian).

The time-delay and pulse characteristics of FEU-30 and FEU-36 photomultipliers with a short (~1 nsec) light burst photocathode and bursts up to 500 nsec are described. (tr-auth)

6346 IONIC MASS SPECTROMETER FOR SPACE RESEARCH. Argence, Emile; Geerk, Jens; Perechodkin, Serge (Institut Franco-Allemand de Recherches, Paris). Compt. Rend., Ser. B, 263: 872-5(Oct. 10, 1966). (In French).

A description is given, along with the characteristics of a highly sensitive continuous measurement mass spectrometer to study the lower regions of the ionosphere. (tr-auth)

6347 NOISE IN PHOTOMULTIPLIERS. Kovaleva, T. A.; Melamid, A. E.; Pertsev, A. N.; Pisarevskii, A. N. (Belorussian State Univ., Minsk). Prib. Tekh. Eksp., No. 5, 5-19(Sept.-Oct. 1966). (In Russian).

A brief review is given on noise sources of photomultipliers, amplitude distribution of noise pulses, and effects of external parameters on the photomultiplier noise. Special attention is given to single-electron noise components. 170 references. (tr-auth)

6348 HIGH TRANSMISSION AND DUAL ELECTRON BEAM ION SOURCES FOR MASS SPECTROMETRY. Melton, C. E. (Oak Ridge National Lab., Tenn.). J. Sci. Instrum., 43: 927-30 (Dec. 1966). (ORNL-P-2134).

Two high transmission electron-bombardment ion sources, based on a principle of electric rather than mechanical ion collimation, were developed and tested with a 6-in. radius-sector type of mass spectrometer. The new ion sources had a measured transmission efficiency of 88 and 85% as measured by two different techniques. One ion source was designed for general use for experiments in which high sensitivity is required, while the second was designed for the study of unstable species such as excited neutral molecules, products of ion-molecule reaction and free radicals. These sources are capable of measuring partial pressures of both unstable and stable species as low as 10 ftorr. Collimating slits of 0.250 in. × 0.500 in. are used throughout the general purpose ion source to give electric rather than mechanical collimation of the ion beam. Electric collimation increased the transmission by over two orders of magnitude with respect to mechanical collimation, whereas the resolution was reduced only by about a factor of six. The "unstable species" ion source utilizes a principle of two parallel electron beams. One electron beam is used to produce a desired species and the second electron beam ionizes the species for mass identification. An experiment in which helium is excited to the 1s2s metastable level by 23-eV electrons in the first electron beam and subsequently ionized in the second electron beam by 6-eV electrons was performed to demonstrate the operation of the source. (auth)

6349 NEUTRON TELEVISION SYSTEM INSPECTION OF RADIOACTIVE FUEL CAPSULES. Berger, Harold; Beck, W. N. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 597 (Oct.–Nov. 1966).

6350 GENERATOR OF DOUBLE SERIES OF NANOSECOND PULSES. Aveynier, J.; Puthod, C. (CEN, Grenoble, France). Nucl. Instrum. Methods, 47: 141-7(Jan. 1967). (In French).

The instrument described is a versatile pulse train generator capable of giving up to a frequency of 10 MHz, two trains of fast pulses of both polarities. It is possible to adjust separately and continuously: the delay between the two trains from 0 to 500 ns, the duration of each train, between 10 and 150 ns and in each train, the time separation of the pulses between 10 and 60 ns. The output signals have a gaussian shape with a rise time of 2 ns, a width of 5 ns and an amplitude adjustable from 0.5 to 2.5 V. (auth)

6351 MICROWAVE PLANAR TRIODES IN PREAMPLIFIERS OF NUCLEAR MAGNETIC RESONANCE SPECTROMETERS. Leskovar, B. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Instrum. Methods, 47: 29-38(Jan. 1967). (UCRL-16917).

Microwave planar triodes are investigated as low-noise devices for preamplifiers of high-resolution nuclear magnetic resonance spectrometers in the frequency band from 10 to 100 MHz. Noise sources, noise figures and a preamplifier circuit for planar triodes are considered. Planar triode noise performance is realistically evaluated by measurements under actual operating conditions. Comparisons with other competitive low-noise devices in the frequency band from 10 to 100 MHz are given. A microwave planar triode preamplifier with high amplification stability was designed; when operated with the optimum value of source conductance, it has a minimum noise figure of 0.35 dB at 24.3 MHz. (auth)

6352 STUDY OF A CASCADE TRANSISTOR TRIGGER AND APPLICATION TO A FAST COINCIDENCE CIRCUIT. Riedinger, M.; Schmitt, F.; Metzger, G.; Sutter, G.; Chevallier, P.; Winter, C. (Institut de Recherches Nucleaires, Strasbourg. Univ., Mulhouse, France). Nucl. Instrum. Methods, 47: 100-4(Jan. 1967). (In French).

A very simple trigger circuit using a transistor working in the avalanche region is described. It leads to a maximum repetition rate of 20 MHz with double pulse triggering. The other performances of the trigger are studied. When used in a coincidence circuit associated with a pulse generator, it yields a minimum resolution time $2\tau = 160$ psec. (auth)

6353 SOME CONCLUSIONS ABOUT FILTERS IN NUCLEAR PULSE AMPLIFIERS. Pinasco, S. F. (Comision Nacional de Energia Atomica, Buenos Aires). Nucl. Instrum. Methods, 47: 71-3(Jan. 1967).

The most usual circuits employed as filters in nuclear pulse amplifiers are analyzed in different situations. (auth)

6354 STUDY OF THE BEAM DIVERGENCE IN AN ELECTROMAGNETIC ISOTOPE SEPARATOR. Chavet, I.; Bernas, R. (CNRS, Orsay, France). Nucl. Instrum. Methods, 47: 77-88 (Jan. 1967).

The various factors affecting beam divergence are studied in the case of an electromagnetic isotope separator equipped with a slit-type emitting orifice and sector-type magnetic field. Assuming the beam divergence to be primarily due to meniscus curvature, a simple relation was found expressing this divergence as a function of the extraction parameters. Ion source parameters affect indirectly the beam divergence through the variation of the ion current density emitted from the meniscus. It is shown that the beam divergence is most conveniently controlled by the adjustment of the interelectrode distance. The beam emitted from a convex meniscus with the largest practical divergence is found to be the most advantageous from the point of view of beam current, ion source efficiency and mass resolution. (auth)

6355 A MAGNETIC FIELD INSTRUMENT FOR THE OGO-E SPACECRAFT. Snare, R. C. (Univ. of California, Los Angeles); Benjamin, C. R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 333-40(Dec. 1966).

A three-axis, fluxgate magnetometer was selected for flight on the fifth Orbiting Geophysical Observatory. This instrument, along with an electron telescope, will provide data for the study of magnetohydrodynamic waves and other magnetic field structures in space. The magnetometer has sufficient dynamic range to measure magnetic field values from the surface of the earth to apogee. In addition to this wide dynamic range, the instrument provides for a resolution at all field values of 1/16 gamma. This resolution and dynamic range are accomplished by employing a tightly fed-back, closed-loop magnetometer and a digital offset field generator in each of the three mutually perpendicular axes. The analog output of each axis is filtered by active filters to prevent frequency aliasing of the signals. The cutoff frequency of these filters is automatically switched to the proper frequency as the spacecraft telemetry data sampling rate is changed. In-flight calibration circuitry provides front-to-back calibration of each magnetometer channel during the flight. Packaging and construction techniques used in this instrument are also discussed. (auth)

6356 FLUXGATE MAGNETOMETER FOR THE APPLICATIONS TECHNOLOGY SATELLITE. Barry, J. Dale; Snare, Robert C. (Univ. of California, Los Angeles). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 326-32 (Dec. 1966).

A satellite-borne magnetometer used to detect magnetohydrodynamic wave propagation within the magnetosphere is introduced. The instrument is a biaxial, closed-loop, fluxgate magnetometer. The unit consists of the basic magnetometer plus additional sections, including a data processor, a field nulling section, and sensitivity selection logic. The basic magnetometer is discussed briefly, the additional sections in greater detail. An in-flight calibration section is discussed and referenced to instrument stability and sensitivity. A brief discussion of the ATS satellite mentions the advantages of its orbit, which is favorable for the study of long-term magnetic field variations and for correlation with plasma and particle experiments also on-board. (auth)

6357 OBTAINING UNIPOLAR IONIZATION BY MEANS OF RADIOACTIVE IONIZERS. Kovtun, V. A.; Stepanenko, V. A.; Udartsev, E. P. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 11: 551-3(1966). (In Ukrainian).

Certain therapeutic methods and the removal of surface charges require the preparation of air masses carrying unipolar ionization. This may be achieved by means of slow electric discharges but more advantageously by using radioactive ionizers, separating the ions of opposite charges by an electric field. The problem was studied using tritium ionizers. The degree of ionization of the air stream passing through a nozzle next to the ionizer was measured by means of a flat condenser. The positive and negative ions were separated from each other on the basis of their differing mobility; if the potential of the electric field does not exceed 200 to 210 V/cm, only positive ions are obtained. A whole battery of ionizers is required to create a large volume of unipolarly ionized gas. (TTT)

6358 ELECTROMAGNETIC UNIDIRECTIONAL AIR VALVE KD-1 WITH A PILOT SIGNAL. Konovalov, E. A.; Ploshchanskii, L. M.; Solov'ev, V. A. (Inst. of Physics and Technology, Leningrad). Prib. Tekh. Eksp., No. 4, 224-5(July-Aug. 1966). (In Russian).

Electromagnetic unidirectional air valves KD-1 with a pilot signal were installed for dosimetric air-control near a VVR reactor. The sixty-five valves operated continuously for 2 years in rarefied 750 torr air system without any breakdown. (R.V.J.)

6359 PREPARATION OF POLARIZED THERMAL NEUTRON BEAM BY MEANS OF COBALT MIRROR STACK. Abov, Yu. G.; Bulgakov, M. I.; Gul'ko, A. D.; Ermakov, O. N.; Krupchitskii, P. A.; Oratovskii, Yu. A.; Trostin, S. S. (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp., No. 4, 195-6(July-Aug. 1966). (In Russian).

A description is given of a stack of cobalt mirrors for developing a polarized neutron flux with 3×10^7 neutron/sec and 90% polarization of 100×10 mm^2 specimens. (tr-auth)

6360 MAGNETIC FIELD METER AUTOMATICALLY ADJUSTED TO THE MEASURED FIELD. Kunstman, V. G.; Tsvetkov, V. N. Prib. Tekh. Eksp., No. 4, 166-8(July-Aug. 1966). (In Russian).

The ratemeter based on proton resonance operates by stabilizing the autodyne amplitude and automatically recording the field resonance magnitude. The meter is capable of automatic recording of a slowly changing magnetic field. The measurement range is 1 to 16 kOe. (tr-auth)

6361 STUDIES OF CHARGED PARTICLE BEAM BY MEANS OF SIGNAL ELECTRODES. Gol'din, L. L. (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp., No. 4, 18-21(July-Aug. 1966). (In Russian).

A theoretical analysis was made of the possibility of measuring characteristics of a charged particle beam by means of signal electrodes. Various shape electrodes are suggested. (R.V.J.)

6362 COLLECTION OF RECOIL ATOMS IN NUCLEAR REACTIONS WITH HEAVY IONS. Mikheev, V. L. (Joint Inst. of Nuclear Research, USSR). Prib. Tekh. Eksp., No. 4, 22-6 (July-Aug. 1966). (In Russian).

The peculiarities of electrostatic collection of recoil atoms and of their adsorption from a gas stream (emitted from a small opening on the target) were studied with a heavy-ion beam extracted from a 150 cm cyclotron. In a set of experiments using He gas, 60 to 80% of the recoil atoms were collected for an area of several mm^2. (tr-auth)

6363 SPARK-CHAMBER AUTOMATIC-SCANNING SYSTEM /SASS/ (Engineering Materials). (California Univ., Berkeley. Lawrence Radiation Lab.). (CAPE-1516).

43 drawings.

An on-line cathode-ray-tube (CRT) scanning system used in

scanning spark chamber film is described. It can also be used as an on-line microfilm reader. (For details see TID-4100 Suppl. 38.) (F.S.)

6364 SLIT CAMERA (Engineering Materials). (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). (CAPE-1513).

14 drawings.

A slit camera used to study the surface appearance of externally cooled fuel elements is described. Slit camera arrangements consist of a moving film holder, rotating specimen holder, and a fixed slit and lens. Movement of the specimen and film are synchronized so that the ratio between linear film speed and specimen surface linear speed is equal to the image object size ratio or camera magnification. (For details see TID-4100 Suppl. 38.) (F.S.)

6365 FLOW REGULATING DEVICES. Dixon, Laurence Charles Ward; Price, John (to English Electric Co. Ltd.). British Patent 1,049,486. Nov. 30, 1966. Filed Nov. 2, 1962.

A flow-regulating device for regulating subsonic flow of a gas stream in a duct is described. The device is used in the cooling system of a gas-cooled reactor, mounted in the inlet end of each fuel channel. The device is contained in a closed system including blowers which force gas upwards through the fuel channels and thence to heat exchangers and back to the blowers. The device consists of a nozzle having a convergent portion into which the coolant gas is admitted, and a divergent portion which forms a throat, and a means of regulation. The nozzle may be used in any application in which regulation of a fluid stream in a duct is required. (F.S.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 8014.

6366 (AD-633774) STUDY OF CHARGE CARRIER COLLECTION FROM INSIDE AND OUTSIDE THE SPACE CHARGE REGION. Basso, Michael J. (Army Electronics Command, Fort Monmouth, N. J.). Jan. 1966. 43p. (ECOM-2660). CFSTI $3.00 cy, $0.65 mn.

A theoretical and experimental study of the collection of charge carriers produced within and outside the space charge region of a p-n type solid-state radiation detector by incident energetic alpha particles of 4.98, 4.67, 3.87, 2.98, and 2.31 MeV energy is described. The depth of the space charge region was made smaller by a variable forward bias voltage externally applied. The magnitude of the applied voltage was smaller than the barrier potential. Measurements were made of the number of collected carriers from inside and outside the space charge region as the depth of space charge region was varied over the range of the incident alpha particle. The measured results show agreement with the theoretical considerations. The collection efficiency of the detector was also investigated and is given, independent of the particle energy, as a function of the applied bias voltage. (auth)

6367 (AD-635228) STUDY FOR GENERALIZED MODEL FOR SEMICONDUCTOR RADIATION RESPONSE PREDICTION. Quarterly Progress Report No. 4, September 15, 1965–February 15, 1966. Raymond, J.; Johnson, R. (Nortronics, Newbury Park, Calif. Applied Research Dept.). Contract DA-28-043-AMC-00423(E). 156p. CFSTI $5.00 cy, $1.00 mn.

The detailed transistor study is emphasized, and shows that the accuracy of the calculated results depends on the accuracy of the calculated primary photocurrent and on the accuracy of the lumped-model parameters in representing the electrical behavior. If the common-emitter ionizing-radiation transient response is calculated without prior ionizing radiation experiments, the calculated result is generally lower than the observed response by about a factor of three over the range of common-emitter circuit parameters. If the internal carrier generation rates are adjusted such that the observed collector primary photocurrent agrees with the calculated waveform, the calculated common-emitter transistor response accurately follows the observed response. Here, accurately means certainly less than a factor of two in the worst combination of external circuit parameters, and usually much better than a factor of two. The accuracy is limited by the detail of the representation of the transistor electrical parameters. The lumped-model representation of the transistor can accurately predict the critical electrical and ionizing-radiation induced transient response of widely varying types of devices. Important second-order effects can be incorporated in the model directly, and always in terms of the basic semiconductor and geometrical parameters. The most serious problem seems to be the determination of the carrier generation rates in the transistor. Independent dosimetry can be used to characterize the exposure radiation environment, but effects of the more complex environment inside the transistor can also be considered. (auth)

6368 (AD-642582) SILICON DIODE FAST NEUTRON DOSIMETER. PHASE III. REVERSE-RECOVERY LIFETIME AS A FUNCTION OF TEMPERATURE. Closser, W. H.; Swartz, J. M.; Thurston, M. O. (Phylatron Corp., Columbus, Ohio). Nov. 1966. Contract DA-18-035-AMC-101(A). 33p. (NDL-TR-83-3). CFSTI $3.00 cy, $0.65 mn.

P-i-n wide-base diodes were made from n- and p-type, float-zone silicon. The diodes were irradiated with fast neutrons and annealed at 58, 100, 150, and 200°C for 175 hours at each step. Reverse-recovery lifetime as a function of temperature was taken before and after irradiation and after each anneal. The temperature dependence of the lifetime indicated very shallow levels which are not in agreement with the existing literature. (auth)

6369 TRANSIENT RADIATION EFFECTS ON THERMOCOUPLES. Leonard, J. H.; Crutchfield, J. S. (Univ. of Cincinnati). Trans. Amer. Nucl. Soc., 9: 570-1(Oct.–Nov. 1966).

6370 ANNUAL CONFERENCE ON NUCLEAR AND SPACE RADIATION EFFECTS, STANFORD UNIVERSITY, PALO ALTO, CALIFORNIA, JULY 18–21, 1966. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 1-356(Dec. 1966). (CONF-660705–).

Forty-two papers are included; separate abstracts were prepared for 31. Nine papers were previously abstracted for NSA; see abstracts under CONF-660705. The two papers not abstracted for NSA deal with vacuum resonant-cavity dielectrometers and transductor circuits for magnet-current regulators. (L.B.S.)

For abstracts of individual papers see: 6300, 6309, 6355, 6356, and 6371–6397.

6371 THEORETICAL AND EXPERIMENTAL DETERMINATIONS OF NEUTRON ENERGY DEPOSITION IN SILICON. Smith, E. C.; Binder, D.; Compton, P. A.; Wilbur, R. I. (Hughes Aircraft Co., Fullerton, Calif.). Contract AF 29(601)-6721. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 11-17(Dec. 1966).

Theoretical calculations were made of the energy deposited in silicon in ionization and elastic interactions by neutrons in the energy range of 60 keV to 15 MeV. In contrast to earlier determinations, care was taken to calculate accurately the effects of atomic recoils. These are of primary importance for permanent effects in silicon at all neutron energies and account for about 30% of the transient ionization at 14 MeV. To test the calculation of the energy deposited by 14 MeV neutrons, experiments were performed with a pulsed d-t generator. The experimental values in rads per unit fluence were $(11 \pm 2) \times 10^{-10}$ rad-cm^2 for special p-n junctions and $(8 \pm 2) \times 10^{-10}$ rad-cm^2 for power transistors. Both experimental values agree, within error, with the calculated value of $(8 \pm 1) \times 10^{-10}$ rad-cm^2. The calculated variation of radiation damage in silicon with neutron energy was compared with existing experimental data. There is general agreement of theory with experiment from 200 keV to 14 MeV. (auth)

6372 STUDY OF n- AND p-TYPE SILICON EXPOSED TO HIGHLY ENERGETIC RADIATION. Wikner, E. G.; Horiye, H. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract DA-49-186-AMC-65(X). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 18-23(Dec. 1966).

A study was made of the effect of highly energetic radiation on n-type silicon using two techniques. First, with electron-spin resonance studies, the energy dependence of formation of the Si-Bl center at 80 and 300°K by 1.5, 2.5, 5, and 30 MeV electrons and by reactor neutrons was determined. In addition, the energy dependence of the production of the divacancy by electrons with energies between 2.5 and 30 MeV in n-type silicon was obtained. Second, using galvanomagnetic techniques, information was obtained on the irradiation response and subsequent recovery during annealing of the conductivity, Hall coefficient, and Hall mobility of n- and p-type silicon. The samples were bombarded at 80°K with 5 to 30 MeV electrons and isochronally annealed to 400°K. A considerable amount of annealing was observed in all cases, but the recovery was never complete. (auth)

6373 DEFECT-IMPURITY RELATIONSHIPS IN ELECTRON-DAMAGED SILICON. Carter, J. R. Jr. (TRW Systems, Redondo Beach, Calif.). Contract NAS5-3805. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 24-32 (Dec. 1966).

Crucible grown p-type silicon crystals with various dopants were irradiated with 1 MeV electrons. The Hall coefficient measurements indicated that the introduction rate of the $E_v + 0.3$ eV energy level was independent of the chemical acceptor atoms and

the dislocation density. This energy level was not found in similar float zone crystals. The evidence supports a defect complex with oxygen, but does not involve atoms of the chemical acceptor. Annealing studies of the $E_v + 0.3$ eV level indicated a first stage annealed at 400°C and a second stage annealed at 550°C. The second phase of this work involves the electron irradiation of heavily doped samples of floating zone silicon. It was found that the defect introduction rate increased very slowly with phosphorus concentration. The introduction rate decreased linearly with the remaining carrier concentration during irradiation. In the impurity conduction region, the activation energy for conduction increased with electron irradiation. Production of vacancy-phosphorus pairs appears to be responsible for the changes observed. (auth)

6374 EFFECTS OF OXYGEN AND DOPANT ON LIFETIME IN NEUTRON-IRRADIATED SILICON. Curtis, O. L. Jr. (Nortronics, Newbury Park, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 33-40(Dec. 1966).

Neutron-induced degradation of carrier lifetime in silicon was observed for n- and p-type material containing various amounts of oxygen and different dopant impurities. There was no observable dependence of lifetime degradation on oxygen concentration. No dependence on type of dopant was observed in n-type silicon, and only small effects appeared to occur in p-type material. Evidently the recombination process is dominated by centers within primary defect clusters, rather than by point defects. These studies indicate that the choice of dopant-impurity or growth technique is usually unimportant in determining device failure in a neutron environment. (auth)

6375 EFFECT OF INJECTION LEVEL ON CARRIER LIFETIME IN NEUTRON-IRRADIATED GERMANIUM. Germano, C. A.; Curtis, O. L. Jr. (Nortronics, Newbury Park, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 47-52(Dec. 1966).

The dependence of minority carrier lifetime on injection level was analyzed to yield recombination center parameters for neutron-irradiated germanium. The results are an improvement over data obtained by other methods because they eliminate a possible dependence of capture probability on temperature, and are more sensitive to energy level position. Six n-type specimens doped with arsenic and antimony in the resistivity range from one to twenty ohm-cm were studied. The results reveal a recombination center level of $E_T - E_V = 0.34 \pm 0.01$ eV for antimony-doped germanium and $E_T - E_V = 0.335 \pm 0.01$ eV for arsenic-doped germanium. The dependence of lifetime on injection level for high excitation demonstrated the appropriateness of the model which includes the effect of a level of $E_C - E_T \sim 0.2$ eV. (auth)

6376 FRACTURE OF SILICON AND GERMANIUM INDUCED BY PULSED ELECTRON IRRADIATION. Oswald, R. B. Jr. (Harry Diamond Labs., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 63-9(Dec. 1966).

Certain preliminary results are presented on the fracture of silicon, germanium, and indium antimonide resulting from pulsed electron irradiation. Experimental results show that the rapid absorption of energy can produce brittle fracture in the semiconducting materials silicon, germanium, and indium antimonide. Samples were irradiated using the external electron beam from a flash x-ray generator having a peak electron energy of 2.2 MeV and a pulse width of approximately 40 nsec. Experimental results on germanium, silicon and indium antimonide have established the fracture threshold for polished and etched bulk material to be approximately 34 cal/g for silicon, about 8.5 cal/g for germanium, and 4 cal/g in indium antimonide. Surface treatment played an important role in the observed fracture level. No dimensional dependence of the fracture threshold was observed using polished and etched bars 1×1 mm^2 in cross section and having lengths between 1 and 25 mm. The fracture planes in both silicon and germanium were found to be the (111) crystal planes and the (110) planes in indium antimonide. (auth)

6377 TRANSIENT IONIZATION EFFECTS IN SILICON INDUCED BY 48 MeV ELECTRON PULSES. Corelli, J. C.; Frederickson, A. R.; Westhead, J. W. (Rensselaer Polytechnic Inst., Troy, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 70-85(Dec. 1966).

Transient radiation effects induced in silicon irradiated in the temperature range 90 to 300°K by 0.007 to 4.5 microsecond pulses of 48-MeV electrons were studied using the transient response of resistivity and Hall effect voltages as the measuring probes. Results are given for one ohm-cm phosphorus-doped n-type silicon and 10 to 100 ohm-cm n-type and p-type samples. In the case of one ohm-cm silicon the results clearly show the actual buildup of excess electrons produced by ionization during the time the electron pulse is irradiating the sample. Moreover, the shape of the pulse during buildup is independent of temperature as long as the electron beam pulse is kept constant. Dependence of the number of injected excess carriers on the ionization intensity (total integrated electron flux in the pulse) was found to be linear up to excess carrier concentrations of $\sim 10^{17}$ cm^{-3}. The lifetime is found to increase linearly with injection implying that the recombination may be dominated by one defect energy level. In p-type silicon the transient Hall and conductivity voltages decay in ~20–50 μsec. Relatively long saturation times (~10 to 100 microseconds) are observed in the transient Hall and conductivity voltage following an electron burst. The saturation time decreases with dose accumulation in p-type and also decreases as the irradiation temperature of the sample (both n- and p-type) is decreased. Very similar effects also are observed in n-type silicon samples. In both n- and p-type silicon the Hall and conductivity voltages decay with about the same time constant. Long-lived resistivity voltage decays were observed in 10 and 100 Ω-cm silicon which are due to imperfections (other than radiation induced) in the crystals. The long-lived decay (or the so-called trapping) is observed to last as long as several milliseconds. The significant "damage mechanism" can be understood by considering only the transient ionization effects, since atomic displacement effects are small and insignificant. No fast annealing is observable. (auth)

6378 DETAILED LUMPED-MODEL ANALYSIS OF TRANSISTOR IONIZING RADIATION EFFECTS. Raymond, James P.; Johnson, Robert E. (Nortronics, Newbury Park, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 95-104(Dec. 1966).

Transient response of a transistor exposed to an ionizing radiation environment can be predicted solely from knowledge of the radiation environment and transistor lumped-model parameters calculated from geometrical and electrical data. Accuracy of the lumped-model transistor representation depends on the detail and accuracy of the data used for calculation of the lumped-model parameter values, an accurate representation of the carrier generation rate in the semiconductor transistor chip, and an accurate representation of the interaction of the radiation environment and the transistor leads and package. In general, it was found that the detailed transistor model represents the common emitter transient response to well within a factor of two. The transistor response is calculated from electrical and geometrical data and the measurement of the radiation intensity from a silicon PIN detector. The transistor response is considered over the entire practical range of quiescent emitter current (<10 μa to >10 ma) and common-emitter source resistance (100 ohms to 10 kilohms). (auth)

6379 SIMPLIFIED ENGINEERING TECHNIQUES FOR PREDICTING DIODE TREE RESPONSES. Carr, E. A.; Walker, K. R. (Hughes Aircraft Co., Fullerton, Calif.). Contract AF 29(601)-6404. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 105-8(Dec. 1966).

The feasibility of predicting radioinduced equilibrium photocurrents in silicon switching diodes entirely from nondestructively measured electrical parameters is shown. The prediction method is derived from the basic theoretical equation for diode photocurrent. Junction areas and depletion widths are related to avalanche voltages and capacitance-voltage characteristics by a general solution to McKay's avalanche condition integral equation. Diffusion lengths are related to storage times. The feasibility of the prediction method is demonstrated by comparing predicted and measured values of equilibrium photocurrents in 46 test diodes. (auth)

6380 BREAKDOWN OF DIELECTRICS DUE TO PULSED ELECTRONS. Rauch, J. E.; Andrew, A. (Lockheed Aircraft Corp., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 109-18(Dec. 1966).

Spontaneous dielectric breakdown was studied in methyl methacrylate polymer, Plexiglas, with a Field Emission Corporation Model 705 Febetron. The breakdown plane was influenced by the presence of embedded metal foils. Charge deposition was measured in a stack of thin sheets of Plexiglas and compared favorably with the calculated charge deposition under the condition of no charge buildup. The energy deposition behind samples of Plexiglas showed a reduction with increased sample thickness. An incident charge density of 4.1×10^{-2} coulombs/M^2 was found necessary to cause spontaneous breakdown in samples thicker than the electron range. The time between the deposition of maximum charge and spontaneous dielectric breakdown was 30 to 40 nanoseconds for an $\frac{1}{8}$-inch thick sample with 7.4×10^{-2} coulombs/M^2 of incident electrons on an $\frac{1}{4}$-inch diameter area. When Plexiglas was irradiated to 7.4×10^{-2} coulombs/M^2, $\frac{1}{16}$-inch thick samples did not show breakdown whereas $\frac{1}{10}$-inch thick samples did show breakdown. (auth)

6381 THEORY OF TRANSIENT ELECTRICAL EFFECTS IN IRRADIATED INSULATORS. Nichols, D. K.; van Lint, V. A. J. (General Atomic Div., General Dynamics Corp., San

Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 119-26(Dec. 1966).

A theoretical analysis of the transient response of insulators to various types of radiation is given by considering the different nature of the paths of ionized electrons that are formed by the primary radiation. Theory shows that for the class of insulators with a low dielectric constant, the transient response from a densely ionizing particle will be much less than that of a lightly ionizing particle for equal amounts of ionization energy deposition because of direct electron-ion recombination. For insulators with a high dielectric constant, the difference in response to the two types of particles is greatly reduced. In addition, a method for predicting the onset of nonlinear response as a function of radiation dose is given. It is seen that competition between direct electron-ion recombination and change in occupancy of the traps can occur. An interesting result of considering the nonuniform generation of electrons is that the response to irradiation by densely ionizing particles should depend on the orientation of the beam with respect to the applied electric field. (auth)

6382 EFFECTS OF PULSED IONIZING RADIATION ON SOME SELECTED QUARTZ OSCILLATOR CRYSTALS. Poll, R. A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Ridgway, S. L. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 130-40(Dec. 1966).

The effects of high-energy ionizing radiation on the behavior and output frequency of electronic oscillators, whose frequency-determining elements were quartz crystals operating in the vicinity of 5 Mc, were studied. Both fundamental and fifth-overtone crystals were studied over a dose range from 3,000 rads (Si) to 2 Mrad (Si) using 25-MeV electrons and 10-MeV peak bremsstrahlung. The crystals were incorporated into commercial precision oscillator circuits and the radiation was collimated to irradiate only the crystal. The crystals studied were of two types: natural quartz and swept pure Z-growth synthetic quartz. The natural quartz showed much larger changes in frequency and transient loss of Q than the swept synthetic crystals. The difference in the response is interpreted as a difference in trap density. (L.B.S.)

6383 LITHIUM-DOPED RADIATION-RESISTANT SILICON SOLAR CELLS. Wysocki, J. J. (RCA Labs., Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 168-73(Dec. 1966).

Photovoltaic measurements indicate that lithium in the n-type region of floating-zone silicon p-n solar cells interacts with radiation damage induced by 1-MeV electrons or 16.8-MeV protons. The centers formed by this interaction do not degrade the minority-carrier lifetime; therefore, these cells are potentially the most radiation-resistant ones available. The interaction involves the motion of lithium; thus, the cell temperature and the radiation rate are important in establishing the amount of degradation which is observed. At room temperature and low rates, the cell output does not degrade. At room temperature and high rates, the cell output degrades but it recovers after irradiation, i.e., the cells are self-healing. The rate which can be used without causing observable decay in the photovoltaic output increases with the cell temperature. (auth)

6384 EFFECTS OF RADIATION DAMAGE ON THE BEHAVIOR OF GaAs p–n JUNCTIONS. Aukerman, L. W.; Millea, M. F.; McColl, M. (Aerospace Corp., El Segundo, Calif.). Contract AF 04(695)-669. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 174-80(Dec. 1966).

The use of radiation damage as a tool for obtaining information about the conduction and injection mechanisms operative in GaAs p-n junctions is illustrated. This is done by varying the minority carrier lifetimes by means of radiation damage and noting the resulting changes in various measured parameters. The electroluminescence (E.L.) and currents in "lightly" doped diodes ($\sim 2 \times 10^{17}$ donors/cm^3) and their behavior after 2-MeV electron irradiation indicate that, although most of the recombination occurs within the depletion region, those few electrons that do succeed in being injected into the conduction band of the p-type side are the ones responsible for the E.L. In the case of "heavily" doped diodes ($\sim 2 \times 10^{18}$ donors/cm^3) at nitrogen temperature the E.L. occurs within the depletion region and is described by the "band-filling" model. The "band-filling" model also describes the behavior of the increase in current resulting from radiation damage. Short circuit current measurements during irradiation indicate that the diffusion length of electrons is much greater than the diffusion length of holes in diffused junctions, and gives additional information about the rate of defect introduction. (auth)

6385 CORRELATION OF ELECTRON-INDUCED CHANGES IN TRANSISTOR GAIN WITH COMPONENTS OF RECOMBINATION CURRENT. Horne, W. E.; Brown, R. R. (Boeing Co., Seattle). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 181-7(Dec. 1966).

After low-exposure dosage of electron and/or gamma radiation, anomalous permanent changes in transistor gain were observed which cannot be attributed to changes in base minority-carrier lifetime or to temporary surface effects. A study of these permanent effects was performed using base current component analysis similar to that applied to neutron damage by Goben. By this method it was possible to observe the buildup with dose of individual components of base recombination current. These components can be related to damage in the base-emitter space-charge region and in the base regions of the devices. It was possible to correlate the buildup and/or saturation of the components with structure observed in the curves of anomalous gain degradation. Furthermore, analysis of damage in the base region revealed two components which appear to be related to changes in the surface recombination velocity and to changes in the minority-carrier lifetime, respectively. (auth)

6386 IONIZATION AND DISPLACEMENT DAMAGE IN SILICON TRANSISTORS. Brucker, G. J.; Dennehy, W. J.; Holmes-Siedle, A. G. (David Sarnoff Research Labs., Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 188-96(Dec. 1966).

An investigation of electron-induced ionization and displacement damage in N-P-N and P-N-P transistors at medium and low powers is presented. Measurements of base and collector currents as a function of base-emitter voltage with radiation as a parameter were made. The transistors were irradiated sequentially with 125 keV and 1 MeV electrons. Initial saturation of surface-damage effects with 125 keV made possible the separation of displacement and surface damage. The results show that the dominant displacement damage occurs within the emitter-base transistor region for fluence levels less than or equal to 5×10^{15} 1 MeV e/cm^2 and emitter currents less than or equal to 10 milliamperes in the 2N2102 and 2N1132 transistors. Above this fluence level, displacement damage in the bulk of the base region becomes effective. Isochronal and isothermal annealing measurements indicate that the results can be explained by attributing the damage in the transition region to recombination current losses at K-centers for N-P-N transistors and A-centers for P-N-P transistors. (auth)

6387 RADIATION HARDENED SAMPLED DATA SYSTEM. Orndorff, R. M. (Hughes Aircraft Co., Fullerton, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 218-21(Dec. 1966).

A radiation-hardened data recording system was designed, fabricated, and tested. The employed data sampling and recording technique samples the input signal waveshape and stores the instantaneous voltage in a memory bank for subsequent data readout or telemetry. A design concept, incorporating parallel write-in, variable-rate sampling and tunnel-diode memory, was implemented for development of a ten-megacycle prototype system. The prototype system exhibited radiation hardness in excess of 3×10^{10} rads(Si)/sec and 10^{14} Nvt, with promise of extending the design concept to provide another order of magnitude radiation hardness. (auth)

6388 IRRADIATION OF MIS CAPACITORS WITH HIGH-ENERGY ELECTRONS. Zaininger, K. H. (RCA Labs., Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 237-47(Dec. 1966).

High-energy electron bombardment of Me-SiO_2-Si and Me-Si_3N_4-Si capacitors was investigated by means of C-V and G-V measurements. The bombardment usually results in the introduction of positive charge into the insulator. This effect is explained by a physical model which involves interaction of secondary electrons with the insulator lattice to generate electron-hole pairs and predominant trapping of holes in the insulator. Dependence of radiation sensitivity on initial surface state density, gate thickness, oxidation procedure, surface orientation, bombardment bias, and previous radiation history, as well as the annealing behavior was studied. (auth)

6389 COMPARISON OF MOS AND METAL-NITRIDE-SEMICONDUCTOR INSULATED GATE FIELD-EFFECT TRANSISTORS UNDER ELECTRON IRRADIATION. Stanley, Alan G. (Massachusetts Inst. of Tech., Lexington). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 248-54(Dec. 1966).

Insulated gate field-effect transistors with silicon dioxide and silicon nitride insulation were irradiated with 1-MeV electrons over a wide range of biasing conditions. In nitride-insulated devices the radiation induced shift in gate turn-on voltage was greatly reduced and source-drain leakage currents eliminated. The dependence of the equilibrium shift in gate turn-on voltage

on gate bias varied critically with the structure of the insulating layer, and an attempt was made to correlate this with charge transfer mechanisms across the interfaces of the insulator. (auth)

6390 RADIATION HARDENING OF MOS TRANSISTORS FOR LOW IONIZING DOSE LEVELS. Barry, A. L.; Page, D. F. (Defence Research Telecommunications Establishment, Ottawa). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 255-61(Dec. 1966).

The effect on MOS field-effect transistors of moderate doses of ionizing radiation (up to a few tens of kilorads) is a lateral shift in the I_d-V_{gs} characteristic. Experimental results are given to describe this shift, particularly for low ionizing doses, and from these results a model similar to others recently published is given to describe the mechanisms involved. The experiments are based on measurements of "small-dose radiation sensitivity," defined for the MOSFET as the incremental shift of gate threshold voltage with the application of an increment of radiation, i.e., $dV_T/d\phi$. Detailed observations of $dV_T/d\phi$ under a variety of conditions of radiation, bias, and temperature, lead to a technique for radiation hardening. Using this technique, the radiation sensitivity can be made negligible for doses up to several thousand rads, at the expense of only minor changes in other device parameters. (auth)

6391 THE EFFECTS OF SPACE RADIATION ON MOSFET DEVICES AND SOME APPLICATION IMPLICATIONS OF THOSE EFFECTS. Gordon, Frederick Jr.; Wannemacher, Harry E. Jr. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 262-72 (Dec. 1966).

MOSFET devices and microcircuits were designed and built into flight hardware for use in open operational spacecraft (IMP D&E) by NASA/GSFC. A look at some of the engineering results associated with studying this class of devices for use in these applications is reviewed. In addition, there is a first-cut engineering study for comparison of performance, in a simulated space radiation environment, of two types of MOSFET's and the newer experimental silicon nitrite devices (MNS-FET). The experiments reported upon are application parameter oriented and of limited sample size. Therefore, no attempt is made to draw any far-reaching conclusions about MOSFET's in general, nor are any devices physics oriented interpretations included. (auth)

6392 A RADIATION-INDUCED INSTABILITY IN SILICON MOS TRANSISTORS. Dennehy, W. J.; Brucker, G. J.; Holmes-Siedle, A. G. (David Sarnoff Research Center, Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 273-81(Dec. 1966).

Data are presented on a room-temperature instability which was observed in certain types of MOS systems after bombardment with ionizing radiation. This instability can cause the transfer characteristic of an irradiated MOS transistor to shift rapidly when bias is applied. The shift can be as much as 3 volts for a unit that has been bombarded with 10^{15} 1 MeV electrons/cm^2. In order to explain this effect it is postulated that the ionizing radiation introduces a number of surface trapping sites in the oxide which can exchange charge very slowly with silicon. Shifts in transfer characteristic under bombardment, due to immobile charge accumulation in oxide were also observed. The shifts observed were unusual in that they indicate negative charge buildup, which is contrary to the usual finding. (auth)

6393 STUDY OF THE TRANSIENT RADIATION RESPONSE OF THIN FILM FIELD EFFECT TRANSISTORS. Krueger, A. F.; Griffin, E. E. Jr. (Autonetics, Anaheim, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 282-6(Dec. 1966).

The effects of transient gamma radiation on thin film insulated gate field effect transistors were studied. N- and p-channel thin film epitaxial silicon nonjunction devices on insulating sapphire substrates were irradiated using a 600 keV flash x-ray. All data were obtained at a dose of 1.0 rad (LiF)/pulse. The reproducibility of the radiation pulse was monitored by a PIN diode photodetector. The effect on the drain current of transient voltages generated in the gate circuit was observed by varying the external gate resistance. In n-type devices, the drain current transient increased with increasing gate resistance, indicating a positive gate voltage transient. In the p-type devices, there was a transient decrease in the drain current. The effect of a silicon substrate versus a sapphire substrate was measured by observing the transient signal on the drain at channel current cutoff conditions. A small signal equivalent circuit is presented which is in agreement with the findings of the study. An equation for the transient radiation effects on thin film field effect transistors is discussed. Using the equation, theoretical calculations of the transient drain current for various gate resistances are shown graphically and are compared with typical data obtained from the study. Calculated and measured data are shown to be in agreement. (L.B.S.)

6394 TRANSIENT HIGH-ENERGY RADIATION RESPONSE IN THE THIN-FILM TRANSISTOR. Emmert, R. R.; Berggren, C. C.; Peffley, W. M.; Honnold, V. R. (Hughes Aircraft Co., Fullerton, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 287-94(Dec. 1966).

The transient response of the polycrystalline CdSe thin-film transistor (TFT) to pulsed ionizing radiation was experimentally observed. The incremental drain current is characterized by a prompt response followed by a much slower decay, which has a time constant of the order of 100 microseconds. This slow portion of the device response was shown to be due to trapping processes in the bulk semiconductor film. A model was developed to explain this response. (auth)

6395 TRANSIENT RADIATION RESPONSE MECHANISMS IN MICROELECTRONICS. Bowman, W. C.; Caldwell, R. S.; Johnston, A. H.; Kells, K. E. (Boeing Co., Seattle). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 309-15(Dec. 1966).

Previous radiation-effect studies on monolithic microcircuits using p-n junction isolation from the substrate showed that failure under pulsed ionizing irradiation occurred because of radiation-induced currents through the substrate junction. It was expected, therefore, that removal of the substrate junction would eliminate this failure mode and lead to a less vulnerable circuit. Since additional construction techniques have become available, a study program was initiated to evaluate the relative radiation resistance of each technique. The goal of this program was to develop an understanding of the radiation response of circuits constructed by means of these various techniques. The important results of this work are summarized, the details of which are reported elsewhere. The work is treated in three subjects: (1) ionizing radiation effects, (2) neutron radiation effects, and (3) latchup. (auth)

6396 MICROCIRCUIT HARDENING STUDY. Sowin, D. C.; Kells, K. E.; Wicklein, H. W.; Hunter, L. T. (Boeing Co., Seattle). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 316-24(Dec. 1966).

The primary purpose of this study is to evaluate methods of hardening monolithic integrated circuits to transient ionizing radiation. This is done by (1) controlling the maximum amount of transistor primary photocurrent through controlled variations in the doping profile, and (2) evaluating different fabrication processes for similar circuits. It is found that photocurrents for similar geometry transistors can be controlled over a range of better than 2:1 with doping variations. Microcircuit output response can be varied over a range of 10:1 with different fabrication processes. Transistor profiles are evaluated using a computer program developed to predict primary photocurrent. Circuit fabrication variations are: diffused and thin-film resistors, oxide isolation, and p-n junction isolation. The circuit design technique using diode compensation of primary photocurrents is investigated. Oxide isolation was the fabrication process that was the hardest to transient radiation for these particular circuits. (auth)

6397 PERFORMANCE OF SILICON CONTROLLED RECTIFIERS IN RADIATION ENVIRONMENT. Smith, Gail D. (Fairchild Hiller Corp., Bladensburg, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 6, 341-9(Dec. 1966).

A study of the effect of gamma radiation upon silicon-controlled rectifiers (SCR's) is presented and correlated with electron radiation encountered by spacecraft. Six electrical characteristics of each SCR were measured before, during, and after exposure to radiation. During irradiation some were unbiased, some biased, and others were pulsed electrically. Additionally, two different dose rates of radiation were employed. Test results are presented in graphic form, showing each of the six characteristics as a function of the total accumulated dose. (auth)

6398 RADIATION EFFECTS ON ELECTRONIC SYSTEMS. Olesen, Henning Lind. New York, Plenum Press, 1966. 245p. $16.50.

The effects of nuclear radiation on electronic and electrical equipment is discussed. Topics included are radiation effects on semiconductors and other materials, passive and active radiation shielding, and recommended experimental methods and simulation facilities for design testing. (B.G.D.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 5747, 6401, 6481, 6544, 6665, 6719, 6729, 6735, and 6737.

6399 (BNWL-SA-955) THE PASSAGE TIME OF PLUTONIUM OXIDE IN PIGS. Smith, V. H.; Ragan, H. A.; McClanahan, B. J.; Beamer, J. L.; Palotay, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 7, 1966. Contract AT(45-1)-1830. 13p. (CONF-660917-5). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Gastrointestinal Radiation Injury Symposium, Richland, Wash.

Fasted, Hanford Miniature Swine were given by stomach tube several thousand, submillimeter particles of refractory plutonium oxide. By the ninth or tenth day 99% of the material was passed, but 100% was not cleared by day 14. Two cases of material hold-up at the ileo-cecal junction were found. (auth)

6400 (CONF-660412-7) TREATMENT OF ACCIDENTAL INTERNAL CONTAMINATION. Lafuma, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by W. K. Dunscombe (Atomic Energy Research Establishment, Harwell, Eng.), from Paper Presented at Symposium on Accidental Irradiation at Place of Work, Nice, France, Apr. 26-29, 1966. 9p. Dep. mn. JCL $1.10 fs, $0.80 mf.

The treatment of internal contamination by radioactive materials depends on the chemical and physical properties of the material, the portal of entry of the material into the body, the distribution of the elemental material in body tissues, and, in some cases, the physiological state of the body. Problems involved in the removal of radioactive materials from the lungs, gastrointestinal tract, puncture wounds, and when diffused into the body are discussed. It is pointed out that the decontamination of the lungs depends on the solubility of the inhaled compound, colloid formation in situ, and elimination of complexes of the material from the body. It is suggested that the inhalation of an aerosol of a chelating agent may hasten lung decontamination. In the case of gastrointestinal tract contamination, the stomach should be emptied and the radioactive material should be made to pass through the intestines in the form of an insoluble compound. Puncture wounds involving radioactive materials should be treated by the administration of drugs to form soluble complexes that can be excreted or by surgical removal of the material. Plutonium in wounds may be excreted after the formation of a stable complex with DTPA, but in the case of Pu nitrates and Pu metal both surgery and DTPA treatment should be used, while only surgery should be used for the removal of Pu oxides. When radioactive materials have diffused from the portal of entry into the body the treatment should be based on the use of drugs to increase plasma clearance and excretion rate and treatments aimed at blocking the accumulation of the material in critical tissues or organs. The effectiveness of injected chelating agents for hastening the excretion of complex-forming elements is discussed, with emphasis on the effects of DTPA on the removal of ^{144}Ce and ^{239}Pu. (C.H.)

6401 (EUR-2983.e) MOLECULAR AND RADIATION GENETICS. Annual Report, 1965. (Leiden Rijksuniversiteit (Netherlands)). Sept. 1966. 24p. Dep. mn.

Investigations of the structural and functional effects of ionizing radiation upon various types of DNA under a variety of conditions are reported, as well as investigation of further promising and far-reaching test systems. The mechanism of induction of mutations in Drosophila by ionizing radiation was studied extensively with emphasis on the elucidation of processes involved in post-radiation repair. Work covering mechanisms of enzyme action and their modification by irradiation and effects in cultured mammalian cells is in progress. (auth)

6402 (IA-1082, pp 203-15) BIOLOGY AND MEDICINE. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

Progress is reported on: dynamic studies of thyroxine deiodination in man; thyroxine metabolism in tumor-bearing rats; effects of cortisol on calcium metabolism in rats; transfer of ^{144}Ce via placenta and during lactation in mice; trace element composition of snake venoms; and reverse transpiration in plants. (H.G.D.)

6403 (NYO-3364-24) GAMMA SPECTROSCOPIC INVESTIGATION OF COW'S MEAT WITH REGARD TO ^{137}Cs CAUSED BY FALLOUT IN NORWAY, AUGUST 1964-AUGUST 1966. Madshus, Kjell (Norsk Hydro's Inst. for Cancer Research, Oslo); Stroemme, Aksel (Norsk Radiumhospital, Oslo). Contract AT(30-1)-3364. 12p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Cesium-137 from fallout was determined in beef produced in Norway between August 1964 and August 1966. One kg samples were prepared from the semi-tendinous muscle. Considerable differences were apparent in the sp act. of samples from three geographic zones in Norway. During the period in question ^{137}Cs sp act. showed seasonal variations similar to those reported for milk, but with less pronounced fluctuations. Concentrations of ^{137}Cs decreased 27% in meat and 66% in milk from August 1964 to August 1966. (H.G.D.)

6404 METHOD FOR MEASURING THE ADSORPTION OF TRITIUM-LABELED COMPOUNDS AND ITS APPLICATION IN THE INVESTIGATION OF SURFACE ACTIVITY OF DNA. Frommer, M. A.; Miller, I. R. (Weizmann Inst. of Science, Rehovot, Israel). J. Colloid Interface Sci., 21: 245-52(Feb. 1966).

A method was developed for the determination of surface concentrations of tritium-labeled compounds at the air/water interface employing a gas-flow counter with an ultrathin (15-30 $\mu g/cm^2$) supported end-window, while the air between the window and the radiating surface is replaced by helium. The considerable improvement in the counting efficiency produced by this method is of special advantage in measuring adsorption at gas/liquid interfaces, since the construction and handling of the system are very simple. Injection of surface-active materials, spreading of monolayers, compression and expansion of surface films, and many other common procedures involved in studying surface properties can easily be performed during the measurement. Thin films for windows were prepared by immersing a glass slide into solutions of Formvar in chloroform or para-dioxane, or of Parlodion in amyl acetate, and floating on the water surface the thin film deposited on the slide. Good windows were prepared from solutions of 4-5 mg/ml by folding the film on itself while depositing it on the perforated support, thus obtaining a double thickness. With such a window the starting voltage of the detector was lower than 1350 v, and the Geiger Region was between 1400 and 1600 v with a plateau of better than 7% per 100 v. The described method was applied in the investigation of either the adsorption of DNA at the air/water interface or its interaction with a monolayer of a basic polypeptide spread at the interface. Calf thymus DNA was tritiated by the Wilzbach method by exposing it to 0.3 atm of tritium at 20-25°C for two weeks. It was found that the direct measurement of adsorption kinetics by the methods described may serve as a new, very efficient, and accurate technic for determining diffusion coefficients of high molecular biological materials at practically zero concentration. (BBB)

6405 PENETRATION OF THOROTRAST INTO BRAIN SPACES FOLLOWING OSMIUM, GLUTARALDEHYDE, AND HYDROXYADIPALDEHYDE FIXATION. Torack, Richard M. (New York Hospital-Cornell Medical Center, New York). J. Ultrastruct. Res., 14: 590-601(Mar. 1966).

Young adult rats weighing 200-300 g were perfused with glutaraldehyde (glutal) and hydroxyadipaldehyde (HAA). Immediately following the perfusion small (1 mm^3) blocks of tissue were cut from rat cortex and immersed in Ringer's solution containing 1% thorotrast. These blocks of tissue were allowed to remain in the thorotrast suspension at 4°C for a period of 20 min, 1 hr, and 24 hr. After incubation the tissues were post-fixed for 1 hr in 1% OsO_4 at 280 mOs. Thin sections were examined with an electron microscope. Some of the sections were examined unstained to facilitate the identification of thorotrast, and others were stained with uranyl acetate. The size and the accessibility of the rat extracellular space to thorotrast appeared to be distinctive for fixation with osmium tetroxide, glutaraldehyde, and hydroxyadipaldehyde. The small glutaraldehyde extracellular spaced did not appear accessible to thorotrast. However, thorotrast did enter the larger extracellular space which could be seen following HAA fixation and to a lesser degree after osmium fixation. In HAA-fixed tissue this space and the contained thorotrast appeared to communicate with the basement membrane of venules. The relation of these findings to morphological and functional properties of the extracellular space is discussed. Thorotrast appeared to pass more readily through cells than between them, probably due merely to the greater cross section area of most cell processes. Even in HAA-fixed tissue the deepest localization of thorotrast appeared to be intracellular. All cells appeared to permit this movement of thorotrast, but neurons, especially following glutaraldehyde fixation, contained the greatest number of particles. This indicates that thorotrast may easily pass through the cyto-

plasm of these cells. The particles were always present in general cytoplasmic ground substance, not within any formed organelles. (BBB)

6406 INACTIVATION REACTION OF TAKA-AMYLASE A BY ULTRAVIOLET LIGHT. Kim, Sam Soon (Kyushu Univ., Fukuoka). Nippon Nogeikagaku Kaishi, 40: 67-72(1965). (In Japanese).

Changes in chemical and biological properties of taka-amylase A were examined when solutions of the enzyme were inactivated by uv irradiation. Oxygen uptake and the amounts of oxidized amino acid residues formed during irradiation were measured by a manometric technique and chemical analysis, respectively. The photoinactivation of the enzyme was attributed to the photo-oxidation of the amino acid residues cystine, trypotophan, and tyrosine. The oxygen uptake of a solution of amylase differed little from that of a solution of an amino acid mixture having the same molar proportions and concentrations as the amylase solution, and it is concluded that the formation of a high polymer structure or of a special conformation of amylase molecule does not measurably affect the oxygen uptake. The photoinactivation is enhanced by the presence of paramagnetic ions, but not by the presence of diamagnetic ions. This was attributed to the spin-orbital coupling by the inhomogeneous magnetic field of the paramagnetic ions. Addition of substrate inhibits considerably the photoinactivation. The effect may be due to the capture of the photoelectron ejected from amino acid residues and/or HO_2 by the substrate and decomposition products. (BBB)

6407 PREFERENTIAL IN VITRO BINDING OF RADIOACTIVE VITAMIN B_{12} BY AN ABNORMAL SERUM PROTEIN IN CHRONIC MYELOID LEUKEMIA. Beal, R. W. (Red Cross Blood Transfusion Service, Adelaide). Nature, 213: 81-2 (Jan. 7, 1967).

It is stated that in spite of considerable past work on the binding of vitamin B_{12} the precise mechanisms of binding and the physiological significance of the binding patterns obtained remain uncertain. In vitro binding of radioactive vitamin B_{12} to normal serum proteins takes place principally in the α_2 and β fractions, while in chronic myeloid leukaemia most of the vitamin is bound to a protein moving with the α_1 globulin fraction, possibly the seromucoid fraction. Studies are described with the ^{58}Co labeled vitamin. Results indicate that the abnormal protein present in the serum of myeloid leukaemia patients, possibly an α_1 acid glycoprotein, binds all added vitamin B_{12} when deficiency of the vitamin is present. The phenomenon of increased avidity for the vitamin appears to be specific and preferential, rather than an overflow phenomenon resulting from saturation of other binding sites. (UK)

6408 MATHEMATICAL MODEL FOR THE BIOLOGICAL EFFECTIVENESS OF RADIATIONS. Angleton, George M. (Colorado State Univ., Fort Collins). Health Phys., 13: 45-50 (Jan. 1967).

Cosmic, electromagnetic, and other radiations in their passage through matter produce modifications of molecular structures proportional to their energy loss per unit length (LET). When the structure is an integral part of a functioning biological system, the degree of modification of biological responses depending on the integrity of this structure is a function of the LET of the radiations. A mathematical model describing the dependency is presented. It is based on the primary postulate that there exists a critical value of the density of the energy deposition for which the contributions to the biological response is a maximum; higher values of energy density deposition correspond to the over-kill concept. An interpretation is given of the parameters of the proposed model together with a discussion as to how they may be estimated. The agreement of this model with existing data is reasonable. The model serves as a basis for extrapolation of existing data to obtain estimates of the biological effectiveness of the cosmic rays that are characterized by extremely high values of the LET. (auth)

6409 PULSE LABELED RNA ASSOCIATED WITH RIBOSOMES IN ESCHERICHIA COLI. Artman, M.; Silman, N.; Engelberg, H. (Hebrew Univ., Jerusalem). Nature, 213: 39-42 (Jan. 7, 1967).

Pulse-labelling studies involving sucrose gradient centrifugation in changing concentrations of magnesium ions were employed to demonstrate that newly synthesized RNA, contrary to the current view, is not reversibly bound to 70S ribosomes, but is attached even in low concentrations of magnesium ions to both 50S and 30S ribosomal subunits. (auth)

6410 THE DIFFUSION OF $^{35}SO_2$ FROM TISSUE FLUIDS INTO THE LUNGS FOLLOWING EXPOSURE OF DOGS TO $^{35}SO_2$. Frank, N. R.; Yoder, R. E.; Yokoyama, E.; Speizer, F. E. (Harvard School of Public Health, Boston). Health Phys., 13: 31-8(Jan. 1967).

The surgically isolated airways of the head and upper neck of anesthetized, paralyzed dogs were exposed to 22 ± 2 ppM of $^{35}SO_2$, delivered at a rate of 3.5 l/min for 30 to 60 min. The lungs were ventilated with ambient air by a positive displacement respiratory pump. In ten out of twelve measurements, over 95 percent of the $^{35}SO_2$ administered to the isolated upper airways was found to be absorbed by the mucosa. In all animals, $^{35}SO_2$ was present in one or more expired gas samples collected either at the carina or from a bronchus. The expired $^{35}SO_2$ could not have entered the lower airways in inspired air, and its presence provided evidence that the lungs were releasing the gas in expiration, presumably from the pulmonary capiliaries. Sulfur-35 was present in the blood and urine within minutes of the onset of exposure to $^{35}SO_2$. (auth)

6411 DEPOSITION OF RADIOACTIVE METHYL IODIDE ON VEGETATION. Atkins, D. H. F.; Chadwick, R. C.; Chamberlain, A. C. (Atomic Energy Research Establishment, Harwell, Eng.). Health Phys., 13: 91-2(Jan. 1967).

Wind tunnel and field experiments to determine the extent of deposition of ^{132}I-methyl iodide on vegetation are described. The experiments indicated that methyl iodide is very poorly absorbed by vegetation. It is possible that the small uptake observed was due to traces of elemental iodine. The possibility arises that prolonged exposure of a cloud of methyl iodide to sunlight might lead to dissociation and formation of elemental iodine, which would then be available to plants. (UK)

6412 ESTIMATION OF DIETARY ^{90}Sr BY URINARY ASSAY. APPLIED AND THEORETICAL ASPECTS. Thompson, J. C. Jr.; Comar, C. L. (Cornell Univ., Ithaca, N. Y.). Health Phys., 13: 5-13(Jan. 1967).

In controlled studies with a group of adults and of 4 to 5-year-old children values were determined for observed ratio $(OR)_{urine/diet}$ (Sr/Ca of urine/Sr/Ca of diet) and relationships established between the $OR_{urine/diet}$ and the urinary calcium excretion. The basis is given for estimation of levels of dietary $^{90}Sr/Ca$ from determinations of urinary $^{90}Sr/Ca$. In adults, the dietary $^{90}Sr/Ca$ was essentially the same as the urinary $^{90}Sr/Ca$; in children, the dietary $^{90}Sr/Ca$ was about 0.5 the value of urinary $^{90}Sr/Ca$. A theoretical model is given to which the data are shown to conform. (auth)

6413 EXCRETION OF ORALLY ADMINISTERED ^{65}Zn BY THE COTTON RAT IN THE LABORATORY AND FIELD. Orr, Howard (St. Olaf Coll., Northfield, Minn.). Health Phys., 13: 15-20(Jan. 1967).

Zinc-65 uptake and excretion by non-starved cotton rats did not differ from levels previously reported by Richmond et al. for the white rat. Subjects starved before ingestion assimilated less zinc, but excreted it at the same rate as non-starved subjects. Uptake levels from solid food and water were similar. During late fall, subjects in a two-acre enclosure excreted zinc more rapidly than laboratory subjects, but no difference between conditions was found during late winter and spring. It appeared doubtful that excretion rates were related to activity levels. (auth)

6414 CATECHOLAMINE BINDING PROTEIN: BINDING OF TRITIUM TO A SPECIFIC PROTEIN FRACTION OF HUMAN PLASMA FOLLOWING IN VITRO INCUBATION WITH TRITIATED NORADRENALINE. Mirkin, Bernard L.; Brown, David M.; Ulstrom, Robert A. (Univ. of Minnesota, Minneapolis). Nature, 212: 1270-1(Dec. 10, 1966).

Experiments were performed to determine whether circulating catecholamines were bound to a specific protein component of plasma in a manner analogous to corticosteroid-binding-globulin or to thyoxine-binding-globulin. Heparinized blood specimens obtained from healthy volunteers were incubated in vitro in plasma containing tritiated noradrenaline. The in vitro demonstration of tritium binding to a specific protein compnent of human plasma suggests that circulating catecholamines are transported from sites of release by a catecholamine-binding-protein possessing electrophoretic migration characteristics quite distinct from albumin. (H.G.D.)

6415 MEASUREMENTS OF ^{47}Ca AND ^{85}Sr IN HUMAN SUBJECTS. Harrison, Joan; McNeill, K. G. (Univ. of Toronto). Nature, 212: 988-90(Dec. 3, 1966).

The calcium and strontium metabolism of fifteen subjects were studied using simultaneous intravenous injections of ^{47}Ca and ^{85}Sr. Activities of urine and feces were measured for 9 days and whole-body retention for periods up to 200 days. Strontium-85 retention was plotted against time on a log scale. For measurements made after 30 days, the results appeared to fit a straight line that could be expressed mathematically as a power function. Direct measurements of the whole-body burden at 9 days were systematically less than the retention values from the initial dose. The mean value of this discrepancy was 12%. The percentage of Sr retained after 9 days was in all cases equal to or less than the percentage of Ca

retained. No discrimination was evident in the section of the two elements by digestive juices. (H.G.D.)

6416 POST-IRRADIATION CHANGES IN THE DEOXYRIBONUCLEOPROTEIN COMPLEX IN ANIMAL TISSUES AS REVEALED BY THE ACTION OF HEPARIN. Skalka, M.; Matyasova, J. (Inst. of Biophysics, Brno). Nature, 212: 1253-5 (Dec. 10, 1966).

Differences observed between the effect of heparin on thymus and spleen DNP from non-irradiated and x-irradiated (600 R) mice proved that serious damage to the DNP complex of spleen and thymus tissues occurs shortly after exposure. (H.G.D.)

6417 COMPARISON OF ^{45}Ca AND ^{14}C-PROLINE AS INDICATORS OF BONE METABOLISM. Firschein, H. E.; Miller, Orlando P. (Cornell Univ., New York). Nature, 212: 1252-3 (Dec. 10, 1966).

Results are presented on studies of bone metabolism in rats using ^{45}Ca and ^{14}C-labeled proline simultaneously. Experimentally produced tibial fractures were used as the stimulus for increased bone turnover. The ratios of the specific activities, fractured/non-fractured, for both ^{45}Ca and ^{14}C were of the same order of magnitude, indicating that both may be used as indicators of bone metabolism. Fractures of the tibial shaft apparently caused an increase in both mineral and collagen turnover in the proximal end of the tibia and the distal end of the femur on the fractured side. (H.G.D.)

6418 STRONTIUM AS A SUBSTITUTE FOR CALCIUM IN THE PROCESS OF TRANSMITTER RELEASE AT THE NEUROMUSCULAR JUNCTION. Miledi, R. (London Univ.). Nature, 212: 1233-4(Dec. 10, 1966).

Strontium ions were applied ionophoretically to a minute part of a neuromuscular junction in frogs to determine: whether strontium ions are capable of replacing Ca in the process of transmitter release; and, if so, whether the transmitter is still released in quantal nature, or whether the quantal nature is dependent on the specific combination of Ca with a receptor in the nerve membrane. It was shown that Sr can replace Ca in the process of transmitter release by a nerve impulse and that the transmitter is still released in quantal fashion. Further, minimal synaptic delay was substantially the same, whether the release occurred in the presence of Ca or of Sr, even though the latter is much less effective in releasing transmitter. It is concluded that the combination of Ca or Sr with a receptor in the presynaptic membrane is a very rapid event that contributes little to the minimal synaptic delay. (H.G.D.)

6419 EFFECT OF HEAVY WATER ON PROTOPLASM FLOW. Huebner, Gerhard (Institut fuer Isotope, Leipzig). Flora (Jena), 156: 245-9(1965). (In German).

Protoplasmic flow was studied in internodal cells of Tolypella nidifica, where it takes place in the internal plasma layer surrounding the vacuoles, and in leaf cells of Elodea densa. These cells show strong rotational movement of the protoplasts for some time after separation of the leaves from the plant. In the T. nidifica cells protoplasmic streaming was from 1.70 to 2.03 times as great in H_2O solution as it was in D_2O. This may have resulted from reduced metabolic activity in presence of D_2O, but it may also have resulted from its greater viscosity and the related increase in streaming resistance. Results similar to these were observed with the E. densa cells. The ratio of protoplasmic streaming in H_2O as compared to D_2O was ~1.7. In addition, when the cell samples of both types of plants were replaced in H_2O after being treated with D_2O, the rates of protoplasmic streaming returned to normal values again. (BBB)

6420 FORMATION OF VACCINIA ANTIGEN STUDIED BY IMMUNOURANIUM AND IMMUNO-DIAZOTHIOETHER-OSMIUM TETROXIDE TECHNIQUES. Donati, Edward J.; Petrali, John P.; Sternberger, Ludwig A. Exp. Mol. Pathol., Suppl. 3: 59-74(1966).

To study the interaction of vaccinia virus and host cell, cytochemical localization of antigens evoked in the cell by infection with the virus was examined in ultrathin sections exposed to labeled antibodies with the indirect immunouranium and immunodiazothioether-osmium tetroxide (immuno-DTO) techniques. Sections treated with diazothioether-labeled sheep antibody to rabbit antibody (TD-anti-RAb) were exposed at 50°C to moist osmium tetroxide vapor for 30 min. Sections exposed to uranium-labeled sheep antibody to rabbit antibody (U-anti-RAb) were not counterstained with osmium tetroxide. Electron micrographs were made of both preparations. Virus followed by U-anti-RAb without osmication or by TD-anti-RAb with osmication specifically stained vaccinia antigens in different cellular locations at 2, 8, and 14 hr after infection and in similar locations at 14 and 20 hr. Intracellular antigen 2 hr after infection was found along the membranous walls of the vesicles of the endoplasmic reticulum, and, occasionally, in the nucleus and close to the pores of the inner nuclear membrane. Eight hours after infection viral antigen was found in diffuse foci in the cytoplasm, also in the nucleus and in the distended perinuclear cistern. Intracellular antigens 14 and 20 hr after infection were associated with immature and mature viral particles, which were seen in clusters in the cytoplasm of each cell. The findings at various times after infection indicate that most events in the formation of viral and extraviral vaccinia antigen take place in the cytoplasm. However, the nuclear association of some specific antigens suggests that at least some of the virus-specific enzymes needed in the formation of cytoplasmic foci of synthesis must be formed in the nucleus. (BBB)

6421 IMMUNO-DIAZOTHIOETHER-OSMIUM TETROXIDE (IMMUNO-DTO) TECHNIQUE FOR STAINING EMBEDDED ANTIGEN IN ELECTRON MICROSCOPY. Sternberger, Ludwig A.; Donati, Edward J.; Hanker, Jacob S.; Seligman, Arnold M. Exp. Mol. Pathol., Suppl. 3: 36-43(1966).

Uranium was used to confer electron-opacity on antibody, and an improved method was developed for preparation of uranium-labeled sheep antibody to rabbit antibody (U-anti-RAb). Preparation of U-anti-RAb was carried out exclusively by filtration and followed by four washings. The antibody rabbit γ-globulin-p-azobenzylcellulose suspension was stirred with 1/100 saturated solution of uranyl acetate. The U-anti-RAb, prepared by this modified procedure using a higher dilution of uranyl acetate during labeling and lower pH at elution, averaged 251 atoms of uranium per antibody molecule as compared to an average of 54 attained in previous preparations. Diazothioether-labeled sheep antibody to rabbit antibody (DT-anti-RAb) was also prepared. The greater stability of osmium over uranium in the electron beam made it possible to use a higher beam intensity without destroying the specimen, and visualization of regions devoid of antigen made focusing easier with DT-anti-RAb-treated sections. In sections treated with rabbit antiserum to vaccinia and with U-anti-RAb, only specific antigen-containing structure was localized, while surrounding structures remained unstained and barely visible. Contrast of specific antigen-containing structures relative to nonspecific areas of the cell was more marked with the immuno-uranium than with the immuno-DTO technique. (BBB)

6422 PERMEABILITY TO THORIUM DIOXIDE OF THE INTERCELLULAR SPACES OF THE FROG CEREBRAL HEMISPHERE. Villegas, Gloria M.; Fernandez, Josefina (Instituto Venezolano de Investigaciones Cientificas, Caracas). Exp. Neurol., 15: 18-36(May 1966).

An electron microscopic study of the permeability to ThO_2 of the brain intercellular spaces was carried out in whole and sliced brains of Rana pipiens. The tissue was fixed immediately after 2-hr incubation in physiological solution containing ThO_2. The average width of the intercellular spaces is the same in the brains incubated in media with or without ThO_2. ThO_2 particles penetrate the intercellular spaces at both cerebral borders and they are found only peripherally in the whole brains and peripheral as well as centrally in the slices. Diffusion of ThO_2 is restricted but not precluded by the epithelial junctions. Thorium is observed also in the synaptic cleft. Intracellular ThO_2, always enclosed in membranous vesicles, is observed in the ependymal cells and in nerve terminals among the synaptic microvesicles. The results demonstrate the existence of a real extracellular space in the brain and its permeability (including the epithelial junctions and synaptic clefts) to particles as large as those of ThO_2. (BBB)

6423 STUDY OF RADIOACTIVE CONTAMINATION (^{131}I) AND ITS PARTITION AMONG THE DIFFERENT PARTS OF TWO MEDITERRANEAN BIVALVE MOLLUSKS. Leandri, Marcel A.-R.; Omez, Dominique (Faculte de Medecine, Marseille). Presse Med., 73: 2917-20(Nov. 27, 1965). (In French).

Uptake and distribution of ^{131}I were studied in Mytilus galloprovincialis and Gryphoea angulata maintained in sea water at constant temperature and salinity. Daily analyses were made of whole-body activity and activity of the shell, soft tissues, and intravalvular liquid. (TSS)

6424 INFLUENCE OF ^{239}Pu ON METABOLISM OF FREE RADICALS IN RABBIT LIVER. Tseveleva, I. A.; Libinzon, R. E. Radiobiologiya, 6: 219-23(1966). (In Russian)

Free ribonucleotide metabolism was investigated in the liver of rabbits given 7 μCi/kg doses of plutonium nitrate intravenously. A substantial decrease was observed in the nucleoside polyphosphate content in the liver. After one month, the ATP and guanosine-5′-triphosphate (GTP) concentrations were approximately half the corresponding control values, while after three and six months they were nine and five times lower, respectively. A distinct increase in the nucleoside monophosphate content was noted in the livers of the experimental animals. In all periods of the investigation, a distinct decrease in the incorporation of radioactive phosphate into cytosine diphosphate-choline was detected, which may be the cause of the appearance of fatty dystrophy of the liver. A certain increase in the rate of incorpora-

tion of ^{32}P into the carbohydrate derivatives of uridine diphosphate occurred one month after the administration of Pu, while after three months this process was 1.6 to 2.4 times as active as normal, which was accompanied by an intensification of the formation of connective tissue and the development of cirrhosis of the liver. (H.G.D.)

6425 BEHAVIOR OF METABOLISM OF ^{85}Sr IN THE BONES OF HYPOPHYSECTOMIZED RATS. Bracci, R.; Benedetti, P. A.; Malandrini, F.; Cordelli, F. (Univ., Siena, Italy). Atti Accad. Fisiocrit. Siena, Sez. Med.-Fis., 12: 1037-42(1963). (In Italian).

The effect of hypophysectomy on the bone incorporation of radiostrontium was studied in Wistar rats weighing 120 to 150 g. Control and hypophysectomized animals were injected intraperitoneally with ^{85}Sr, 3 μC per animal. Thirty minutes later, and at 1, 3, 4, 6, 12 hr, and daily for 12 days, radioactivity of the animals was followed, after which time the animals were sacrificed to determine residual radioactivity in bone and carcass. Whole-body activity, measured as percentage of maximum activity, declined more slowly in hypophysectomized rats than in intact rats. At the end of 8 days residual radioactivity was ~59% and 40% in the two groups respectively. Both carcass and bone of hypophysectomized animals had higher levels of ^{85}Sr than controls, but the percentage of the total-body radiostrontium that was present in bone was higher in intact than operated animals (82 vs 70%). The ^{85}Sr uptake time curve showed essentially 3 phases: an initial rapid distribution in the body which became maximum at the 6th hr, a period fairly rapid elimination from the body between the 6th hr and 2nd day, followed by a slower elimination rate. It is concluded that hypophysectomy retards the elimination of radiostrontium from bone. (BBB)

6426 ON THE MECHANISM OF INACTIVATION OF ANTIBODY ACTIVITY OF ^{60}Co GAMMA RADIATION. Seth, Shanti K. (Univ. of Texas, Austin); Rajam, P. C. Immunochemistry, 3: 177-94(1966).

Correlation between ^{60}Co radiation dose and inactivation of combining activity of anti-p-aminobenzoate antibody indicated that a relatively large number of reactions was associated with inactivation. The molecular rearrangement suggested by viscosity and disulfide analysis is probably related to the inactivation process, rather than to mere secondary radiation-induced damage of material already inactivated, since, they were first measurable at doses of 7×10^4 and 15×10^4 rad, respectively, as compared to D_{37} of 35×10^4 rad. The irradiated material was found to contain, in addition to a grossly denatured fraction insoluble at low ionic strength, some subtly denatured fractions. These fractions were demonstrable by such sensitive techniques as elimination patterns in rabbits and rates of tryptic hydrolysis. Augmented inactivation above that resulting from irradiation alone, was demonstrated to follow mild postirradiation heat treatment (40-41° for 3 hr). This increased heat-induced inactivation was not accompanied by detectable changes in viscosity or in the number of disulfide bonds available for reduction. It appeared to relate to the presence of molecular species, in irradiated antibody solution, that had undergone almost complete disorganization of combining sites, since attempted stabilization of combining site by p-iodobenzoic added before heat treatment could not protect against the additional loss of activity (BBB)

6427 EFFECT OF IRRADIATION ON ACCUMULATION AND MOBILITY OF RADIOACTIVE ^{45}Ca IN COTTON AND BROAD BEAN PLANTS. Guseinov, S. G. Dokl. Akad. Nauk Azerb. SSR, 21: 71-5(1965). (In Russian).

Growth and development of bean and cotton plants following seed exposure to radiation doses of 500, 1000, or 5000 R were determined in plants growing in soils to which $^{45}Ca-CaCl_2$ was added during flowering. Calcium-45 uptake by leaves was studied 24 and 48 hrs after addition of the label. Accumulations of ^{45}Ca were greater in young leaves of nonirradiated controls. Doses of 500 and 1000 R increased the ^{45}Ca content of young leaves, but the 5000 R dose resulted in ^{45}Ca levels below those of the controls. (H.G.D.)

6428 PHOTOCHEMICAL INACTIVATION OF TAKA-AMYLASE A. Kim, Sam Soon (Kyushu Univ., Fukuoka) J. Fac. Agr. Kyushu Univ., 13: 729-41(Feb. 15, 1966).

Taka-amylase A is markedly inactivated by uv light, or by visible light but only in the presence of riboflavin. The inactivation in both cases is ascribed to the photooxidation of constituent amino acid residues, although the detailed mechanism of the photochemical processes is quite different. These were studied in solutions of the enzyme by oxygen uptake during photoinactivation, quantitative determination of oxidized amino acid residues, and spectra for photoinactivation. To further clarify the photophysical and photochemical mechanisms leading to the inactivation of amylase, the effect of perturbation of paramagnetic ions on these processes was studied. It was shown that the photoinactivation of taka-amylase A in the absence and presence of sensitizer, riboflavin, is due to the photo-oxidation of certain amino acid residues, mainly cystine, tryptophan, tyrosine, and histidine. The process of ejection of photoelectrons from the triplet state via excited singlet state is important for uv-induced inactivation. The stabilization of triplet state of riboflavin is an important process for the riboflavin-sensitized photoinactivation of taka-amylase A. These processes are affected by the spin-orbital coupling effect in the presence of paramagnetic ions. The formation of enzyme-substrate and product complexes protects the enzyme from uv and visible inactivation. The viscosity increase of solutions in the presence of substrate and products may decrease the collision frequency between active oxygen and amino acid residue This also may play a part in the decrease of oxidation reaction rate that was observed. (BBB)

6429 AUTORADIOGRAPHIC RESEARCH ON THE INCORPORATION OF $Na_2{}^{35}SO_4$ IN THE REGENERATING LIMB OF THE AXOLOTL (AMBYSTOMA MEXICANUM) AFTER X-RAY IRRADIATION. Kao, Hui (Inst. of Experimental Biology, Shanghai). Shih Yen Sheng Wu Hsueh Pao, 10: 285-97(Dec. 1965). (In Chinese).

The incorporation of $Na_2{}^{35}SO_4$ was studied in various tissues of the normal regenerating limb of the axolotl (Ambystoma mexicanum) after x-irradiation. The materials obtained attest to the relatively slow rate of metabolism in axolotl. Maximum incorporation of $Na_2{}^{35}SO_4$ in sulfomucopolysaccharide occurs on the fifth day after injection. A significant incorporation of radiosulfur is noted in the muscles, the perichondrium, and in the connective tissue. The regenerating blastema is distinguished by the high incorporation level of labeled sulfate, which is connected either with the intensification of the synthesis of acidic mucopolysaccharide or, rather, with the formation of certain complex predecessors of these compounds. This attests to the fact that until morphological differentiation takes place in the cell of the regenerating cartilages, an accumulation of ^{35}S-sulfate, a definite chemical differentiation, is observed. In the course of differentiation of the blastema, an increase of the incorporation of ^{35}S-sulfate into the cells of the embryonic cartilage takes place. In the periphery zone of the regenerate, occupied mainly by the myoblasts, a reduction of the incorporation level of radiosulfate is observed during the same period. The incorporation of $Na_2{}^{35}SO_4$ in the limb or regenerating nodule, after local irradiation, does not differ from the control. In the irradiated regenerating limb, the accumulation of ^{35}S-sulfate remains at the same level. (TSS)

6430 A CASE OF ACCIDENTAL INHALATION OF ^{65}Zn AND ^{110m}Ag. Newton, D.; Holmes, A. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Res., 29: 403-12(Nov. 1966). (AERE-R-4577).

The behavior of zinc-65 and silver-110m in a man who accidentally inhaled these nuclides has been studied over a period of 2 years by using body radioactivity measurement with γ-ray scintillation spectrometry; in addition, an extended program of excretion analysis was undertaken. Lung clearance for the silver-110m was apparently completed within a few days, but proceeded more slowly for the zinc-65. However, a widespread distribution of zinc-65 in the soft tissues was apparent from the early stages, with an appreciable concentration in the liver during the first 100 days. The silver-110m showed a marked localization in the liver, exhibiting a biological half-life of about 50 days in this organ. The measured whole-body retentions of both nuclides could be expressed as two-component exponential functions of time. Of the absorbed zinc-65, 27% declined with a biological half-life of 18 days, but the major fraction (73%) was retained with a biological half-life of 453 days. Most of the silver-110m disappeared very rapidly, with a half-life of approximately 1 day, but about 15% was retained with a biological half-life of 52 days, which was very similar to that found for the liver content. About 20% of the total daily excretion of zinc-65 was urinary, but the silver-110m was apparently excreted only in the feces. (auth)

6431 DUAL MECHANISMS OF ION ABSORPTION IN RELATION TO LONG DISTANCE TRANSPORT IN PLANTS. Luttge, Ulrich; Latties, George G. (Technishce Hochschule, Darmstadt, Ger.). Plant Physiol., 41: 1531-9(1966).

The characteristics of ion transport to the shoots of young corn seedlings were studied with respect to the nature of the isotherm through a wide concentration range, the competitive influence of closely related ions upon the transport of a given ion, and the influence of the counter-ion. Both with respect to ^{36}Cl and ^{86}Rb transport, the characteristics of the process in every way resemble uptake by non-vacuolate root tips wherein the plasma membrane involved in absorption, and where system 1, of the 2 systems which can be shown to participate in absorption by vacuolate tissue, is the only system operative. Net ion uptake by the roots per se was shown to display both the high affinity (system 1) and low affinity (system 2) mechanisms. It is concluded

that the symplastic theory of ion movement to the xylem is valid, and that the contention that system 1 operates at the plasma membrane while system 2 functions at the tonoplast is strengthened. (auth)

6432 PHYSIOLOGICAL BASIS OF DIFFERENTIAL STRONTIUM ACCUMULATION IN TWO BARLEY GENOTYPES. Pinkas, Leonard L. H.; Smith, Lawrence H. (Univ. of Minnesota, St. Paul). Plant Physiol., 41: 1471-5(1966).

Studies of rates of Sr transport from nutrient solutions containing 8 concentrations of Sr indicate a definite trend towards higher rates of Sr transport by roots of intact 12-day-old Regal barley (Hordeum vulgare, L.) seedlings as compared with Tregal. Differences in rates of Sr transport between the 2 varieties were also indicated by higher concentrations of Sr in fluids exuding from decapitated Regal roots as compared to fluids exuding from Tregal roots. No differences between Regal and Tregal were found in the physical factors of distance from epidermis to endodermis, number of cortical cell layers, or transpiration rate. Furthermore, no relationship was observed between transpiration rate and rate of Sr accumulation. Dependence of Sr transport on metabolic processes was indicated by marked effects of temperature, cyanide, and dinitrophenol on rates of Sr transport. Q_{10} values for Sr transport by Regal and Tregal approached 2, thereby indicating that metabolic reactions were associated with this process. Strontium transport by both Regal and Tregal was markedly depressed in the presence of either cyanide or dinitrophenol. These results led to the conclusion that the Sr transport process is dependent on metabolic energy derived from respiration. (auth)

6433 RADIOLYSIS OF PEPTIDES IN γ-IRRADIATED AQUEOUS SOLUTIONS. Sultanov, A.; Knalikov, D. R.; Ibrazimon, A. P. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Uzb. Biol. Zh., 9-11(1966). (In Russian).

The effect of γ radiation on the yields of ammonia and peroxide under different conditions in aqueous solutions of dipeptides, tripeptides, and tetrapeptides was investigated. In glycol–norvaline and in glycol–valine, in comparison with other dipeptides the yield of ammonia is higher. This is maintained during irradiation under different conditions. The yield of peroxide from dipeptides is almost similar. As a measurement of the growth of dipeptide bonds the yield of peroxide increases and of ammonia decreases, which is perhaps the results of the interaction of OH and HO_2 radicals with carbonyl groups of peptide bonds. (tr-auth)

6434 SODIUM ACTIVATION IN GOATS EXPOSED EITHER BILATERALLY OR UNILATERALLY TO FAST NEUTRONS. Batchelor, A. L.; Edmondson, P. W. (Medical Research Council, Harwell, Eng.). Brit. J. Radiol., 39: 859-66(Nov. 1966).

After whole body exposure of goats to fission neutrons the plasma ^{24}Na concentration was found to be linearly correlated with dose over the range 0 to 2,400 rads. The slope of the regression line for males and females was different, probably because of sex differences in either spatial distribution of body sodium or tissue dose. Variation in body weight had a smaller but statistically significant effect. For goats exposed under similar geometrical conditions the standard deviation of the dose estimate derived from plasma ^{24}Na measurements was ±8%. Although the relation between dose and sodium activation was the same for unilateral and bilateral irradiation, the biological outcome for the same dose was not identical. (auth)

6435 DNA STRAND BREAKAGE BY X-IRRADIATION. Freifelder, David (Univ. of California, Berkeley). Radiat. Res., 29: 329-38(Nov. 1966).

Bacteriophage DNA has been x irradiated both free in solution and in the phage head and in several solvents. By ultracentrifugal analysis, survival curves for the percentage of unbroken double-stranded and single-stranded molecules as a function of dose have been obtained. From the D_{37} the rates of production of double-strand and single-strand breaks per rad per unit molecular weight have been derived. The effect of a variety of conditions has also been measured. Some of these values may permit an assessment of the relative contribution of strand breakage to the inactivation of simple microorganisms. (auth)

6436 PECULIARITIES OF THE EFFECTS OF VARIOUS TYPES OF RADIATION ON THE HIGHER NERVOUS ACTIVITY OF ANIMALS. Livshits, N. N.; Korolevskii, A. P. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 411-17(1966). (In Russian).

The comparative effects of gamma radiation, neutrons, and protons on the conditioned reflex activity of mice and rats were investigated. The animals responded to the conditioned stimulus by running to the drinking bowl upward along a plane with a 35° slope. The latent period of the reaction, rate of running, and duration of stay of the animal by the drinking bowl were recorded automatically with a system of photocells and an electronic device. After neutron irradiation the latent period of the positive conditioned reflexes was lengthened, while the rate of running and duration of stay by the drinking bowl were reduced. The number of cases of extinction of conditioned reflexes increased. In animals subjected to gamma irradiation, the indices of higher nervous activity were changed in the same direction as in animals irradiated with neutrons, but in the former the changes were less sharp. In rats irradiated by protons at a dose of 150 R, many of the indices of the stimulatory process were increased. Disturbances of the higher nervous activity of animals subjected to radiations of various doses were more severe, the greater the linear ionization density. The RBE, according to the indices of higher nervous activity that were investigated, was greater than 1 for neutrons, and less than 1 for protons with an energy of 510 MeV. (H.L.W.)

6437 CHOLINESTERASE ACTIVITY IN THE HYPOTHALAMUS, THALAMUS, CERTAIN REGIONS OF THE CORTEX, AND CEREBELLUM OF DOGS RECOVERED FROM ACUTE RADIATION SICKNESS. Davydov, B. I. Radiobiologiya, 6: 418-22(1966). (In Russian).

Six months after irradiation, the cholinesterase activity in the prepyriform-periamygdalic and frontal-limbic regions of the cortex and hippocampus was changed inconsequentially, while the enzyme activity in the thalamus increased. In the cortex of the hippocampus after ten months, and in the paleocortex and neocortex 14 months after irradiation, an increase in the cholinesterase activity was observed. During these periods after irradiation, the cholinesterase activity in the hypothalamus and thalamus was lower than in the control. The cholinesterase activity of the subcortical and cortical regions of the brain in dogs recovered from acute radiation sickness varied in opposite directions. (auth)

6438 INVESTIGATION OF THE AMOUNT OF RNA IN THE CELLS OF THE SPINAL CORD DURING GAMMA IRRADIATION. Shungskaya, V. E.; Zarkh, E. N.; Nikolaeva, N. D. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 353-5(1966). (In Russian).

Rats were gamma irradiated and the spinal ganglia and sections of the spinal cord were removed. The RNA content was determined by spectrophotometric methods. It was observed that the RNA content of the cytoplasm of the irradiated cells of the spinal ganglia was 23% less than that of controls after one hour and remained at that level for six days. The motor cells of the spinal cord showed a 21% decrease in the RNA content one hour after irradiation. After one and six days the RNA content in these cells becomes somewhat greater than in the cells of the spinal ganglia, although it does not return to normal in the 6 day period. A similar tendency of variation was observed in a study of the electrocolloidal properties of the RNA of the cytoplasm of irradiated spinal ganglia and motor cells of the spinal cord according to the shifts of the isoelectric points of the tigroid RNA. These studies demonstrate the radiosensitivity of the nucleoprotein metabolism in the cells of the nervous system. (H.L.W.)

6439 RAT BLOOD PROTEINS DURING RADIATION INJURY. Kashkin, K. P.; Aleksandrova, S. V. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 6: 362-8(1966). (In Russian).

Radiation injury of rats is accompanied by changes in the quantitative composition of the serum proteins, of a phase character. At the first stage, the rapid drop in the concentration of serum proteins is associated with a decrease in the content of albumins and β-globulins in the blood, with the gradual restoration of these fractions at the second stage, lasting nine to ten days. The antigenic spectrum of the serum proteins in rats of the Avgust line (24 antigens) is distinguished by great stability, and varies little when the animals are irradiated. An increasing physicochemical heterogeneity of the β_2B- and β_3B-globulins, with the appearance of a "rapid" or "slow" fraction, retaining (β_3B) or somewhat changing their antigenic properties (β_2B), is noted earliest of the symptoms that appear in the experimental animals. Beginning with the seventh day after irradiation, a new "radiation" antigen is detected in the serum; in electrophoresis it migrates together with the slow α_2-globulins and is denoted as the α_2x-protein. This protein is not detected in the irradiation of sera in vitro and is absent both in healthy and in artificially infected nonirradiated animals. (auth)

6440 MECHANISM OF THE ACTION OF IONIZING RADIATION ON THE ACETYLCHOLINE CONTENT IN THE TISSUES OF THE SMALL INTESTINE. Keel, E. O. Radiobiologiya, 6: 369-72(1966). (In Russian).

The first day after total γ irradiation of rats at a dose of 800 R, the acetylcholine content in the tissues of the small intestine is increased. The cholinesterase activity is essentially unchanged in the tissues of the small intestine on the first day after total γ irradiation and is reduced in the blood serum. Partial vagus de-

nervation causes an increase in the acetylcholine content in the tissues of the small intestine; the cholinesterase activity in this case is unchanged. The existence of a relationship between the increase in the acetylcholine content and intensification of the activity of the second neuron of the parasympathetic innervation mechanism of the intestinal wall seems possible. The intensification of the activity of the second neuron in irradiated animals may be explained by limitation of the inhibiting influence of the preganglionic neuron. (auth)

6441 INTENSIFICATION OF AUTOLYSIS OF GLYCOGEN IN THE RAT BONE MARROW UNDER THE INFLUENCE OF TOTAL X RAY IRRADIATION. Filippova, V. N.; Soldatenkova, L. I.; Seits, I. F. (Leningrad Scientific Research Inst. of Blood Transfusion). Radiobiologiya, 6: 373-6(1966). (In Russian).

Under the influence of total x ray irradiation at a dose of 1000 R, 24 hours after irradiation, rat bone marrow extracts cleave glycogen added to them at a rate almost three times as great as do extracts of the bone marrow of control animals. The intensified decomposition of glycogen depends chiefly upon the activation of α-amylase. (auth)

6442 BIOCHEMICAL CHARACTERISTICS OF THE MOST ACUTE FORM OF RADIATION SICKNESS. Strelkov, R. B.; Semenov, L. F. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Radiobiologiya, 6: 377-80(1966). (In Russian).

The ammonia content of blood and brain tissue of guinea pigs was determined after total body gamma radiation at a dose of 1400 R. There was no significant change in the ammonia content of brain tissue. In another series of experiments with an extremely high dose of radiation which produced acute radiation sickness, the functional changes in the central nervous system could be divided into 2 stages, the first characterized by a sharp inhibition, and the second, or spasmodic reaction. In the first stage there was a 36.6% decrease in the free ammonia nitrogen content in the cerebrum. In the second, or spasmodic, stage there was a sharp increase in the free ammonia content in the brain tissue. There was no increase in the ammonia content of the blood, while the amido nitrogen of the blood glutamine was increased. (H.L.W.)

6443 ASSIMILATION OF GLUCOSE IN RATS INJURED BY POLONIUM. Vasilevskaya, V. V. Radiobiologiya, 6: 479-81 (1966). (In Russian).

Pronounced symptoms of injury were observed in rats injected subcutaneously with polonium; after 12 days they were given labeled glucose solution intravenously and control rats were also given labeled glucose. The rats were killed after 10 min and the tissues were analyzed for glucose. Larger quantities of glucose were detected in the liver, brain, kidney, and blood in the polonium-treated animals. In experiments to study the influence of polonium on oxidation of glucose, rats were given carbon-14 labeled glucose and the activity of exhaled air was determined in polonium-treated and control rats. It was found that the rate of elimination of labeled carbon increased in the polonium-injured rats. In experiments on rats with experimental diabetes it was demonstrated that in the diabetic rats the oxidation of the glucose was decelerated in comparison with controls. The administration of insulin intensified the process of glycogenolysis to a greater degree in the polonium-injured animals. (H.L.W.)

6444 CONTENT OF BETA AMINOISOBUTYRIC ACID IN LIVERS OF IRRADIATED RATS. Mazurik, V. K. Radiobiologiya, 6: 482-3(1966). (In Russian).

The content of beta-aminoisobutyric acid in rat liver was determined after whole-body x irradiation. The maximum increase, 2.4 times as great as the control, was observed 8 hours after irradiation. This peak coincided with the accumulation of the maximum amount of nucleotides and nucleosides in the regenerating tissues as a result of decomposition of DNA. Since the DNA content of the liver varies little after irradiation, the source of beta-aminoisobutyric acid is evidently the DNA fragments penetrating from the organs of the abdominal cavity, including thymidine and thymine, which ensure increased formation of beta-aminoisobutyric acid in the liver. (H.L.W.)

6445 INFLUENCE OF PROLONGED GAMMA IRRADIATION OF PLANTS ON THE PHYSIOLOGICAL AND BIOCHEMICAL PROCESSES AND THE PRODUCTIVITY OF POTATOES. Grechushnikov, A. I.; Serebrenikov, V. S. (Scientific Research Inst. of Potato Raising, Moscow). Radiobiologiya, 6: 474-7(1966). (In Russian).

Gamma irradiation of potato plants during vegetation induces a deceleration or acceleration of the plant growth, depending upon the dose rate. The influence of γ rays during vegetation on potato plants affects the uptake of phosphorus into the plants from the soil. Inhibition of the absorption of phosphorus occurs at a dose rate of 5.5 R/hr. When the plants are γ-irradiated at 0.00693 R/hr, radioactive phosphorus is assimilated by the plants in large quantities. In potato plants irradiated by large doses of γ rays, the processes of photosynthesis and outflux of the assimilates formed from the leaves are inhibited. When potato plants are γ-irradiated at a lower dose rate—0.007 R/hr, an intensification of the outflux of plastic substances is observed. The productivity of the potato plants is inversely proportional to the doses of prolonged irradiation. Thus, at a dose rate of 16.7–7.9 R/hr, the yield of the plants is only 26.3–38.9% of the control. With decreasing dose rate, an increase in the yield is observed, and at a dose rate of 0.007–0.002 R/hr, the greatest productivity of the potato plants was noted. (auth)

6446 THE INFLUENCE OF DIETARY FAT ON THE INCORPORATION OF T_2O IN AVIAN TISSUES. Niesar, K. H. (Univ., Munich). Zentralbl. Veterinaermed., 12: 644-52(Dec. 1965). (In German).

Principles for radiochemical measurement of ^3H and its use as tritiated H_2O in experimental studies of chain lengthening of medium length fatty acids in animals are described. To determine total radioactivity of the tissue specimens, the samples were combusted and the combustion products measured by liquid scintillation. Determination of the sp act. of the individual fatty acids was carried out by a combination of gas chromatography and liquid scintillation measurements. The values for individual amino acids were determined after their separation on automatic chromatographic columns in an anthracene cell that made measurement of radioactivity possible by scintillation methods. The sp act. of the substrates indicated that the differences were related to the metabolic coefficients of the organs studied. The concentrations of ^3H in fatty acids of phospholipids were two to three times as great as those in neutral fats. The results confirmed the hypothesis that the chains of exogenous fatty acids become lengthened during metabolic turnover. (BBB)

6447 EFFECTS OF X-IRRADIATION ON RIBOTIDE [RIBONUCLEOTIDE] METABOLISM IN GUINEA PIGS. Kanno, Iwao; Ito, Yasuhiko; Katakura, Yasuhiro; Nakamura, Iwao (Tohoku Univ., Sendai). Sci. Rep. Res. Inst. Tohoku Univ., Ser. C, 11: 433-7(Mar. 1964).

Guinea pigs were subjected to 500-R single whole-body x-irradiation doses and investigation was made of the early changes of nucleic acid metabolism, quantitative changes of ribonucleotides, incorporation of ^{32}P into ribonucleotides, and structure of ribonucleotides in various organs. Ribonucleotides in spleen, small intestine, and testis (with an exception of cytidylic acid in small intestine) markedly decreased 2 hr after irradiation. This was more marked in testis than in spleen and small intestine. At 24 hr after irradiation, the decrease of ribonucleotide contents in spleen was greater than that at 2 hr, while cytidylic and adenylic acids in small intestine stayed at the value noted 2 hr after irradiation. The ^{32}P uptake of ribonucleotides showed changes parallel with the quantitative changes of ribonucleotides. The incorporation of ^{32}P decreased in parallel with the decrease of ribonucleotides. In the spleen, compared with the control, guanylic and cytidylic acids increased while uridylic acids decreased 2 hr after irradiation. Guanylic acid increased and uridylic acid decreased in the spleen 24 hr after irradiation. In the testis, guanylic and uridylic acids increased and cytidylic acid decreased 2 hr after irradiation. Guanylic, cytidylic, and uridylic acids all decreased 24 hr after irradiation. Thus the relative value of each nucleotide revealed organ specificity. Changes in the purine/pyrimidine ratios are also recorded. (BBB)

6448 ACTION OF THE THYROTROPIC HORMONE ON METABOLISM OF ^{85}Sr IN BONES OF THE HYPOPHYSECTOMIZED RAT. Bracci, R.; Benedetti, P. A.; Cordelli, F. (Univ., Siena, Italy). Atti. Accad. Fisiocrit. Siena, Sez. Med.-Fis., 12: 1465-8(1963). (In Italian).

It was found that hypophysectomy increases the incorporation of radiostrontium in bone and retards its elimination from bone. Experiments were conducted in hypophysectomized Wistar rats, weighing 120 to 150 g, to investigate the effect of thyrotropic hormone (TSH) on radiostrontium metabolism in bone. The hypophysectomized rats were injected twice weekly with 3 units of TSH for three weeks. They were then injected with 5 μCi of ^{85}Sr, and their radioactivity was followed for five days. The TSH-treated hypophysectomized rats eliminated ^{85}Sr more slowly than control rats. The amount of radioactivity, expressed as percentage of the max level reached, was 70.5 and 68% in treated and control (intact) rats at one day post-injection, 65 and 50% at two days, and 51 and 43% at 4 days. When the percentage of radioactivity in bone, based on total-body radioactivity was determined, it was found that TSH-treated, hypophysectomized rats had lower proportions of ^{85}Sr in bone than intact rats (66% vs 72%). It was evident that TSH treatment tended to normalize the derangement in radiostrontium metabolism in bone found in hypophysectomized rats. (BBB)

6449 INTRA-HEPATIC LOCALIZATION OF ^{32}P-LABELED PARTICLES ADMINISTERED BY ENDOPORTAL AND INTRA-SPLENIC INJECTION. Caldarola, L.; Badellino, F.; Cavalli, A.; Calderini, P.; Santoro, L.; Del Fante, F. M. (Istituto di Oncologia, Turin). Panminerva Med., 7: 176-84(May 1965).

Experimental and clinical studies are reported on the development of a method for intra-arterial irradiation of the liver for metastatic cancer. Two ^{32}P-labeled preparations were used: a colloidal complex of ^{32}P with $Cr(OH)_3$ having a particle size of 0.1 to 1 μ, and ^{32}P-labeled microspheres (cationic exchange resin) of 30 to 60 μ size. Investigations were made of the distribution of both preparations in liver and carcass of rabbits after injection into the portal system and of clinical findings in patients with tumors in liver after intraportal injection. After injection of 100 μC of the ^{32}P colloid into the portal vein of rabbits, liver radioactivity accounted for 80 to 90% of the amount injected from 10 min to 2 months later. With the microspheres ~99% of the radioactivity was confined to liver 10 min to 24 hr later. Autoradiography demonstrated the even distribution of the microspheres in liver. Four patients with tumor disseminated in liver were injected with 3 to 4.5 mC of the colloid. Postmortem studies showed that the ^{32}P was localized in healthy liver tissue rather than in the tumor. Negligible levels of radioactivity were present in lung, spleen, bone marrow, and blood. After injection of 15 mC of the microspheres into the superior mesenteric artery of another patient, the liver failed to accumulate the radioactivity and excessive amounts were found in lung, heart, and intestine. (BBB)

6450 INFLUENCE OF CALCIUM, MAGNESIUM, AND STRONTIUM ON THE TRANSMISSION OF ^{90}Sr FROM FEMALE RATS TO OFFSPRING. Annenkov, B. N. Radiobiologiya, 6: 455-8(1966). (In Russian).

An increase in the calcium in the diet from 0.3 to 2.0% causes a 2.2–2.6-fold decrease in the deposition of strontium-90 in the skeletons of females and reduces the accumulation of the radioisotope in their offspring by 1.7–3.0-fold during the intrauterine period of development. Diets with an increased calcium, magnesium, or strontium content reduce the retention of strontium-90 in lactating rats by 2.3–2.9-fold and lower the accumulation of radioactive strontium in the baby rats that they nourish by 1.9–6-fold. (auth)

6451 ACCUMULATION AND DISTRIBUTION OF ^{90}Sr IN VARIOUS ORGANS AND TISSUES OF SHEEP AFTER CHRONIC ORAL ADMINISTRATION. Panchenko, I. Ya.; Sarapultsev, I. A. Radiobiologiya, 6: 459-63(1966). (In Russian).

In the case of chronic intake of strontium-90 per os, equilibrium of the isotope in the blood of sheep is established in four to five days, while in the muscle tissue equilibrium is established five to seven days from the beginning of poisoning. The concentration factor of radiostrontium in the muscles does not exceed 0.0028, while the multiplicity of accumulation is 0.045. The discrimination factor of strontium-90 with respect to calcium in the "feed–muscles" system is equal to 0.24. The accumulation of strontium-90 in bone tissue is nonuniform. A more intensive accumulation is observed during the first month after the beginning of poisoning, as well as in the summer to autumn period. Twenty-four months following the beginning of poisoning, the concentration factor of strontium-90 in the skeleton was 1.67 ± 0.26, while the multiplicity of accumulation was 7.6 ± 2.0. The observed effective biological half-life of strontium-90 in the skeleton increases with time, reaching 300 days by the end of two days. The accumulation of strontium-90 in the sheep skeleton during prolonged chronic intake of the isotope with the feed can be described by one exponential function with effective biological half-life of 310 days and coefficient of deposition equal to 0.02. (auth)

6452 QUESTION OF ANEMIC LIVER INJURY IN RATS AND MICE. Skalka, M. (Inst. of Biophysics, Brno). Physiol. Bohemoslov., 14: 358-65(1965).

A significant relation was found between the degree of anemia and fatty infiltration of the liver in irradiated mice and rats. Measures that lowered the oxygen supply or increased oxygen consumption raised the incidence and degree of fatty infiltration of liver in irradiated mice. Thus fatty infiltration of the liver was related to severe anemia and the associated anoxia of liver tissue. The relation between the degree of anemia and the total liver lipid concentration was studied in rats treated with antibiotics and blood transfusions after a single lethal dose of radiation (580 to 660 R), in rats exposed to repeated irradiation, and in rats and mice to which repeated doses of the cytostatic busulfan were administered. It was demonstrated in all the experiments that liver injury developed only in animals with severe anemia, as found in earlier experiments in which mice and rats were exposed to a single dose of radiation. This confirms that severe anemia and associated anoxia of the liver tissue are important pathogenic factors in the development of liver injury. Although the radiation doses used did not injure the liver tissue directly, the possibility still remains that the liver was simultaneously, partly injured by other changes produced by radiation or by the cytostatic agent, thus making it more sensitive to oxygen deficiency in anemia. (BBB)

6453 ESTIMATION OF BONE MINERAL TRANSFER RATE BY THE MEASUREMENT OF LONG-TERM RETENTION OF ^{85}Sr. Shimmins, J.; Smith, D. A. (Western Infirmary, Glasgow). Metab., Clin. Exp., 15: 436-43(May 1966).

Theoretical aspects of bone-seeking isotope kinetics in bone and body fluids are considered, and the model derived was used as a basis of interpreting clinical experiments on radiostrontium incorporation in bone. A whole-body counter was used to study the long-term retention of ^{85}Sr following the injection of 30 μC into 4 patients with osteoporosis and one patient with Paget's disease for periods up to 160 days. The data showed that a single exponential is obtained between 40 and 160 days in all the patients. This, in conjunction with the data obtained from autoradiography, suggests that the isotope is exchanging back from diffusely labeled fully mineralized bone, and from the incompletely mineralized hotspots of active bone formation at very similar rates. This also means that no isotope is permanently locked away during active bone formation. Therefore, any method of estimating bone formation which depends upon this assumption is incorrect. Furthermore, since isotope is present in both the fully mineralized and mineralizing bone, no true estimate of bone mineralization rate can be obtained by isotope tracer studies as the relative proportions of isotope in these different bone compartments cannot be calculated. Nevertheless, these estimates may be clinically useful. Resorption of isotopically labeled bone was not found to be a problem in the patients studied. The body retention as estimated by the whole body counter, and the measurement of fecal and urinary isotope loss, was found to be in good agreement in 3 osteoporotic subjects. (BBB)

6454 INFLUENCE OF TREATMENT WITH TETRACYCLINE ON THE DYNAMICS OF ^{85}Sr IN BONES OF THE GROWING RAT. Benedetti, P. A.; Bracci, R.; Cordelli, F. (Univ., Siena, Italy). Atti Accad. Fisiocrit. Siena, Sez. Med.-Fis., 12: 1469-72(1963). (In Italian).

The known deposition of tetracycline in bone tissue suggested its possible use to influence the distribution of bone-seeking radionuclides in bone. Male rats of the Wistar strain were given 100 mg daily doses of chlortetracycline parenterally for 10 days, at which time they were given 5 μC of ^{85}Sr in a single dose. The max radioactivity of bone was reached at 4 hr in both groups; thereafter there was a marked difference in the ^{85}Sr accumulation in the two groups. After 2 days the control rats had retained 62% of the max level and the antibiotic-treated rats 27%; at 4 days the respective values were 51 and 12%, and at 8 days 39 and 9%. The percentage of the dose found in bone ash based on the total-body level was 84 in controls and 69% in tetracycline-treated rats. The total radioactivity in both ashed bone and total carcass was slightly higher in the rats given tetracycline. (BBB)

6455 RIBOFLAVIN-SENSITIZED PHOTOINACTIVATION OF TAKA-AMYLASE A. Kim, Sam Soon (Kyushu Univ., Fukuoka). Nippon Nogeikagaku Kaishi, 40: 73-9(1966). (In Japanese).

Enzyme activity is markedly diminished when solutions taka-amylase A are irradiated in the spectral range 320 to 500 μ in the presence of riboflavin. The inactivation of amylase is ascribed to the photo-oxidation of amino acid residues. Complete inactivation of the enzyme was obtained after the oxidation of about 70% tryptophan, 45% histidine, 20% tyrosine, 4% methionine, and 17% cystine residues. The photo-oxidation of amino acids is affected by their state, that is, whether they are free or bound to a high polymer. The effects of denaturation and formation of the enzyme-substrate complex on photo-oxidation of amino acid residues are discussed. The inhibition of photo-inactivation and oxidation, and the quenching of fluorescence and phosphorescence of riboflavin were investigated in the presence of paramagnetic ions. The results showed that the triplet state of riboflavin seems to be essential for the riboflavin-sensitized photoinactivation of taka-amylase A. (BBB)

6456 VARIANCES IN THE LEVELS OF SERUM LYSOZYME IN γ-IRRADIATED MICE. Mestecky, J.; Jilek, M.; Mareckova, Marie (Inst. of Microbiology, Prague). Folia Microbiol. (Prague), 11: 179-83(May 1966).

Attempts were made to find the lowest dose of irradiation which would result in alteration of serum lysozyme and, in other experiments, to substitute for the loss of lysozyme from serum after high doses of irradiation by injections of lysozyme so as to minimize the deaths of irradiated animals. Groups of 20 CBA mice were γ irradiated (^{60}Co) with 20, 50, 100, 200, 400, and 800 R. Irradiation of mice with a dose of 20 R resulted in a rise of

lysozyme levels as early as the first day and continued up to the 3rd to 6th day. After 50 R a rise in the level of serum lysozyme was observed. After 100 to 400 R the lysozyme level began to decrease on the first day. On the third day a transient rise was observed, followed by a decrease to the lowest levels demonstrated (usually about the 9th day). Afterwards the normal level of lysozyme was reached and the increase maintained till the end of the 6th week. The dose of 800 R caused a progressive decrease in lysozyme level beginning the first day. Attempts were then made to protect the irradiated animals by administration of lysozyme. Other mice were irradiated with 900, 950, and 1000 R, and half of the animals in each group was injected subcutaneously with lysozyme (50 mg/kg weight, i.e., 1 mg per mouse). Survival of the animals was observed for one and a half months. The results showed no significant differences between the two groups. (BBB)

6457 STRONTIUM AS A SUBSTITUTED STRUCTURAL ELEMENT IN CELL WALLS OF RHIZOBIUM. Humphrey, Beverlev A.; Vincent, J. M. (Univ. of New South Wales, Kensington). Nature, 212: 212-13(Oct. 8, 1966).

Strontium, but neither magnesium nor barium, was effective as a substitute for calcium in supporting growth and normal morphology, and in providing resistance to lysozyme, except when EDTA was present. It could be inferred that strontium was taking the place of calcium as a structural part of the cell wall. A table shows the content of calcium, strontium, and magnesium in whole cells and cell walls of Rhizobium trifolii. The data show that the total of divalent cations in whole cells and separated walls of organisms grown in strontium solution was slightly higher than in cells with adequate calcium, which reflects the lower efficiency of strontium in supporting growth and protecting against lysozyme. (H.L.W.)

6458 EXPERIMENTAL STUDIES ON THE ANTIGENICITY OF ORGANS AND SERUM OF X-IRRADIATED ANIMALS IN THE HOMOLOGOUS ANIMAL. PART III. STUDIES ON THE SIGNIFICANCE OF X-IRRADIATED SERUM AS A CARRIER OF THE ERYTHRON-ALLERGY BETWEEN HOMOLOGOUS ANIMALS. Sakakura, Takehiko (Mie Prefectural Univ., Tsu, Japan). Arerugi, 15: 91-6(Feb. 1966). (In Japanese).

The antigenicity of x irradiated serum in homologous animals was examined by use of the erythron-allergy phenomenon. Serum of irradiated rabbits was added to bovine erythrocyte cephalin. This mixture was used for sensitizing and provoking erythron-allergy in the rabbit. Typical hypoplastic anemia was induced by the injection of the mixture, and the results resembled those seen in erythron-allergy induced using heterologous protein as a carrier. In contrast to these findings, nonirradiated serum or serum irradiated in vitro failed to cause any of these changes. These results indicate the x irradiation of the liver in rabbits induced derangement of the protein synthesis in the liver resulting in homologous antigenicity of the serum as evidenced by the positive erythron-allergy when the serum was used in combination with the erythrocyte cephalin fraction. Results of these three groups of experiments indicate that irradiation of the liver causes denaturation alterations of somatic protein, which may act as a homologous antigen and induce similar clinical findings to those of so-called auto-immune disease. (BBB)

6459 ULTRAVIOLET INACTIVATION OF TRANSFER RIBONUCLEIC ACID FUNCTIONS. Harriman, P. D. (Institut du Radium, Paris); Zachau, H. G. J. Mol. Biol., 16: 387-403(Apr. 1966).

Soluble RNA (sRNA) of Escherichia coli and yeast were uv irradiated at various wavelengths under various conditions. Phenylalanine and lysine acceptance and transfer, as well as the binding of the corresponding aminoacyl transfer RNA (tRNA) to ribosomes, were found to be inactivated with simple exponential kinetics. It is concluded that the target for inactivation of these tRNA functions is small, and that there is a high overlap between the three targets of the phenylalanine tRNA functions and a low overlap between those of the lysine tRNA functions. Two lysine tRNA's were shown to differ in the uv sensitivity of their amino acid acceptance. It was found that the ATP acceptance of partially degraded sRNA is sensitive to uv radiation. Various attempts to restore activity in uv-irradiated tRNA were unsuccessful. The irradiated sRNA was characterized by its absorption spectrum and its thermal denaturation profile. Irradiated phenylalanyl and lysyl tRNA's were cochromatographed with the unirradiated tRNA's on columns of Sephadex and methylated albumin. Various results, particularly the wavelength dependence of quantum yield, suggested a hypothesis which implicates a change in secondary structure resulting predominantly from the formation of uracil dimers as cause of uv inactivation of E. coli phenylalanine and lysine tRNA's. (BBB)

6460 TRANSFER OF WATER FROM MATERNAL BLOOD TO AMNIOTIC FLUID OF LIVE AND DEAD FETUSES IN HEALTH AND IN SOME PATHOLOGICAL CONDITIONS OF THE MOTHER. A STUDY WITH TRITIUM-LABELLED WATER. Tervilae, Leo (Univ. Central Hospital, Helsinki). Ann. Chir. Gynaecol. Fenn., 53: Suppl. 131, 1-69(1965).

In 26 test subjects, methods were investigated for the study of the rate and routes of transfer of water from the maternal blood to the amniotic fluid near term by HTO. HTO, 200 μC, was injected into the amniotic fluid of 7 subjects and into the maternal blood circulation of 6 others, and the changes in the radioactivity of water in successive samples of amniotic fluid and maternal blood collected during given periods of time were measured. The dispersion of the results in the group in which the tracer was injected into the maternal circulation was slightly less marked, and this method was therefore adopted. Although the fetus of 6 test subjects had died in utero, there was considerable transfer of HTO from the maternal blood into the amniotic fluid. The relative rate of transfer was one-half of the rate in 6 subjects with a live fetus. Thus part of the water transported from the maternal organism into the amniotic fluid passes across the fetal membranes either directly or by the placenta, even when there is no blood circulation in the latter. The length of time elapsed since fetal death, 1-5 days, did not appear to influence significantly the rate of water transfer. The transfer of water in early pregnancy was studied by the intravenous injection of 200 μC of HTO into the circulation of 12 test subjects with fetuses of 59 to 107 days of gestational age. At a minor Caesarean section performed 4 to 80 min after the injection, samples were obtained of the placenta, fetus, amniotic fluid and maternal blood and the radioactivity of water in the specimens was measured. The specific activity was found to decrease in the following order: maternal blood = placenta > fetus > amniotic fluid. The length of the time interval after the injection did not change the order of magnitude of the radioactivities. In considering the radiation hazard to which the test subjects were exposed, the dose of radioactivity absorbed by the whole body of the subject was calculated. Following intravenous injection of the dose used, the average daily irradiation during the first week was 0.77 mR and during the first year 0.072 mR. A practical basis of comparison was considered to be the radiation dose from natural background activity, 0.3 mR per day. Accordingly, the average daily radiation dose from the experiments during the first year was about one-fourth of that of natural radiation. (BBB)

6461 SUPPRESSION OF IMMUNOLOGIC RESPONSES. Makinodan, T.; Albright, J. F.; Perkins, E. H.; Nettesheim, P. (Oak Ridge National Lab., Tenn.). Med. Clin. N. Amer., 49: 1569-96(Nov. 1965).

The action of ionizing radiation, and other physical and chemical agents, in suppressing immunogenic reactions is reviewed, with reference to 147 reports. Kinetic studies reveal that, when animals are exposed to total-body irradiation, one or more of the various indices of immune response may vary independently; e.g., under a certain condition the latent phase may be prolonged, the T_2 of the log phase may be unaltered, the length of the log phase may be extended, and the titer of the stationary phase may be higher than normal. Until it is possible to assess the relative contribution of variable regulatory factors and antigen to the immune response, equal weight may be assigned to all these indices. When this is done to assess the effects of the temporal relation of x irradiation and antigen injection on the immune response of mice, four generalizations can be made: (1) Secondary responders are generally more resistant to radiation than primary responders. (2) Antibody response is maximally depressed when animals are irradiated a few hours to two days before antigen injection. (3) Antibody response is nearly optimal, or at times supraoptimal, when animals are irradiated several days, on occasion several hours, after injection of an antigen which is readily catabolized. (4) Secondary responses are suboptimal when animals are irradiated before or after primary antigen injection. Proliferating cells are rendered incapable of unlimited division by ionizing radiations presumably because the genetic apparatus is damaged irreparably. There is similarity in radiosensitivity of different proliferating mammalian cells. That is, the D_{37} dose ranges less than three-fold from about 60 to 150 R, and still less when only hematopoietic cells are compared. Thus, adequately primed secondary responders are less sensitive to ionizing radiation than primary responders mainly because they possess more progenitor cells. This hypothesis was tested directly by determining the relative antibody-forming potential of spleen cells from nonprimed and primed mice immediately after exposure to varying doses of irradiation. The results demonstrate that the magnitude of decrease in antibody-forming potential after exposure to a given dose of radiation is the same for nonprimed and primed spleen cells. It is unnecessary to postulate the existence of proliferative properties among these progenitor cells which are distinct from those of other proliferating mammalian cells. (BBB)

6462 BEHAVIOR IN THE RABBIT OF SERUM ISOZYMES OF LACTATE DEHYDROGENASE AFTER IRRADIATION AT THE HEPATIC, CARDIAC, AND MUSCULAR LEVEL. Cenciotti, L.; Sanna, G. (Ospedale Civile, Cesena, Italy). Arch. Sci. Med., 119: 1-13(Jan. 1965). (In Italian).

Paper electrophoretic studies of serum lactic dehydrogenase isozymes were conducted in rabbits receiving local doses of 800 R of 180-kv x rays to the heart, liver, and muscle. Cardiac irradiation was carried out with a lead shield having a 2-cm aperture over the precordial region. The liver and hind leg were irradiated through a 2×3 cm aperture. Serum was examined 24 hr after irradiation. The relative percentages of the I, II, III, IV, and V isozyme fractions were as follows: controls 20.6, 26.2, 23.8, 11.7, 17.7; hepatic irradiation 8.8, 16.7, 23.7, 17.7, 33.1; cardiac irradiation 37.2, 30.2, 11.4, 7.1, 13.9; muscle irradiation 20.9, 26.1, 22.8, 11.4, 18.6. Thus after liver irradiation there was a drop in fractions I and II and an increase in V. Fractions I and II rose after cardiac irradiation as fraction III decreased sharply. Muscle irradiation did not appreciably alter the isozyme pattern. These results tend to confirm the cardiac origin of fractions I and II and the liver origin of IV and V. Evidently skeletal muscle does not contribute to the circulating lactic dehydrogenase isozymes. (BBB)

6463 WATER-SOLUBLE INHIBITOR(S) OF TUMOR RESPIRATION FORMED FROM ULTRAVIOLET-INDUCED OXIDATION OF LINOLEIC AND LINOLENIC ACIDS. Baker, Nome; Wilson, Leon (Veterans Administration Center, Los Angeles). J. Lipid Res., 7: 349-56(May 1966).

Inhibition of Ehrlich ascites carcinoma respiration by aqueous extracts of oxidized linoleic or linolenic acid (aqueous emulsions uv irradiated, 90 min) was associated entirely with relatively involatile compounds which were both thiobarbituric acid (TBA)-reactive and peroxidase-reactive. Inhibitory compounds were heat stable and migrated in thin-layer chromatography with aldehydes, hydroperoxides, and TBA-reactive compounds. Peroxidase-catalyzed reduction of the hydroperoxide diminished the inhibition. At 4.7×10^{-5} M hydroperoxide concentration, the residues from both linoleic and linolenic acid inhibited tumor oxygen consumption to a similar degree. However, at this concentration of hydroperoxide only the dried extract from linolenic acid was able to produce inhibition (100%) of aerobic glucose utilization by tumor cells. No glycolytic inhibition by the dried residue of oxidized linoleic acid was observed. At least 12 compounds (approximate chain length, 7C-13C) containing α,β-unsaturated carbonyl groups were isolated by gas-liquid chromatography (GLC) of dried extracts of oxidized linolenic acid. No single fraction inhibited tumor respiration, but the recombined mixture of all compounds caused complete respiratory inhibition of ascites tumor cells. Less material was required to inhibit oxygen consumption before than after GLC presumably because the more highly inhibitory components of the extract (along with hydroperoxides and TBA-reactive compounds) were lost during GLC. Extracts from oxidized linolenic acid were found to produce in all tumor cells cytoplasmic evaginations which were readily detected by phase microscopy. (BBB)

6464 IRON METABOLISM STUDIED WITH THE ISOTOPE ^{59}Fe IN EXPERIMENTAL LEAD POISONING. Sroczynski, Jan; Jonderko, Gerard; Watras, Jan (Zabrze Inst. of Oncology, Gliwice, Poland). Arch. Immunol. Therap. Exp., 14: 536-42(1966).

With the purpose of elucidating the character of the disorders of iron metabolism in the course of lead poisoning, ferrokinetic experiments were carried out in rabbits poisoned with lead acetate, using radioactive ^{59}Fe. Markedly accelerated plasma turnover of Fe, increased erythrocytic Fe turnover, and marked acceleration of Fe incorporation in newly produced erythrocytes were found. The findings indicate profound disorders of iron metabolism in lead poisoning, undoubtedly related to hemolysis and impaired binding of Fe in erythrocytes. (auth)

6465 STRONTIUM DISTRIBUTION IN GOATS MILK AND MILK DECONTAMINATION. REPORT 2. Prinz, W. H.; Huebner, H. (Tieraerztliche Hochschule, Hanover). Arch. Lebensmittelhyg., 15: 62-6(Mar. 20, 1964). (In German).

After peroral administration of ^{89}Sr to goats 20% or less was found in milk of lactating goats, of which 75 to 80% was found to be bound to the casein fraction, while 4 to 6% was found in the fat fraction. After in vivo incorporation, ^{89}Sr is bound more firmly by casein than is Ca. It is not definitely established that ^{89}Sr is quantitatively released from casein by shifting the pH of milk to 5.2 or 5.4. With large volumes of milk it is difficult to shift the pH to these values because the β and γ casein tend to be precipitated. These two forms of casein make up more than 30% of the total casein. Ruminants have the capability of decreasing the ^{89}Sr/Ca ratio in milk as compared to this ratio in feed. This ratio can be improved further by doubling the Ca concentration of the feed. The costs of decontamination of milk by means of ion exchange procedures might increase the final price of milk by from 20 to 30%. (BBB)

6466 STUDIES OF THE INCORPORATION OF ^{32}P IN VARIOUS SECTIONS OF THE RACHITIC RAT FEMUR UNDER THE INFLUENCE OF VITAMIN D_3 AND UV IRRADIATED MILK. Faizy, A. Heidelberg, Univ., 1964. 41p. $2.00 Gmelin, AED-Diss. 64-2001.

Thesis.

Rachitic rats were given 5 μCi ^{32}P in combination with various quantities of vitamin D_3 and uv irradiated milk. Activity in femurs was determined after 24 hr. An increase of ^{32}P incorporation by vitamin D_3 and milk was observed. Results indicate that very low vitamin D_3 quantities are sufficient. (auth)

6467 RADIATION EFFECTS ON VITAL AND LYOPHILIZED TISSUE. Kulozik, S. Heidelberg, Univ., 1963. 66p. $2.00 Gmelin, AED-Diss. 63-824.

Thesis.

Histological radiation effects on normal and dried tissue for doses between 500 and 2000 R are investigated. Changes are the same for normal and dried tissues. (auth)

6468 ^{210}Po: A NATURALLY OCCURRING COMPONENT OF FALLOUT. Hill, C. R. (Royal Cancer Hospital, Surrey, Eng.). 15p. (CONF-747-3). ORAU.

From 4th Symposium on Radioactivity in Scandinavia, Riso, Denmark, Oct. 1964.

A brief review is given of the natural occurrence and behavior in the biosphere of isotopes of polonium, and in particular of ^{210}Po, which arises, in association with ^{210}Pb, as a decay product of atmospheric radon. Polonium is absorbed to an appreciable extent through the human gut and is deposited in the body in a characteristic pattern which includes gonads and other soft tissues. In the general population, ^{210}Po body burdens probably arise as a combined result of ingestion and inhalation both of the isotope itself and of certain of its radioactive precursors particularly ^{210}Pb. Results are given of ^{210}Po measurements in the environment generally and in human foods and human tissues collected in both temperate and arctic latitudes. Mean dose rates found in bone of arctic residents have been as high as 600 mrem/year and the corresponding genetic dose rate is estimated to be of the order of 100 mrem/year. (auth)

Ecology

Refer also to abstract 6614.

6469 (ORO-3514-1) USE OF RADIOISOTOPES FOR STUDIES ON THE ECOLOGY OF TICK VECTORS OF DISEASE. Progress Report, April 1, 1966–January 1, 1967. Sonenshine, Daniel E. (Old Dominion Coll., Norfolk, Va.). Dec. 12, 1966. Contract AT(40-1)-3514. 60p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Engorged female ticks (Dermacentor variablis, Dermacentor andersoni, and Amblyomma americonum) were inoculated with ^{14}C-glucose or ^{14}C-glycine during varying oviposit periods. Progeny of those inoculated during the late oviposit period were unsuitable because of the low radioactivity levels. A more uniform yield was obtained in the 1–5 day oviposit periods. Large populations of labeled progeny were produced. The results of field trials with radioactive larvae demonstrated the feasibility of recapture of radioactive individuals on hosts. It was concluded that mass labeling by inoculation of suitable radioactive materials can be used in field studies on the ecology of ticks. (C.H.)

6470 (RLO-353-7) NATURE OF INDUCED MUTATIONS IN HIGHER PLANTS. Nilan, R. A. (Washington State Univ., Pullman. Dept. of Agronomy). Aug. 30, 1966. Contract AT(45-1)-353. 29p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Genetic mutations are considered in relation to single and multistrand chromosome models. Differences in induced and spontaneous mutations are discussed. Induced mutations in higher plants are generally recessive; when dominant or semi-dominant, occur more frequently in polyploids; appear to be chiefly extragenic; and exhibit a high degree of pleiotropism. Types of extragenic mutations are described. Evidence for induced point mutations is presented. Alterations of the mutation spectrum and mutagen specificity are discussed. Approximately 124 references are cited. (H.G.D.)

6471 POSSIBILITY OF CONTAMINATION OF INSECTIVOROUS GAME BIRDS DURING ECOLOGICAL INVESTIGATIONS USING INSECTS LABELED WITH ^{60}Co. Wegorek, Wladyslaw; Glogowski, Kazimierz; Czaplicki, Edward (Inst. of Plant Protection, Poznan, Poland). Prace Nauk. Inst. Ochrony Rosl., 5: No. 2, 19-28(1963). (In Polish).

An evaluation was made of the extent to which various tissues of game birds incorporate radiocobalt from eating insects contaminated with the radionuclide. Muscle, liver, heart, stomach, and

blood of pheasants (Phasianus mongolicus) fed Colorado beetles (Leptinotarsa decemlineata) containing ^{60}Co were examined. The birds were fed with different amounts (from 13.0 to 25.0 μC) of ^{60}Co contained in the insects, and were killed on 6th day after the last feeding. The pheasants excreted about 95% of the fed radioactivity in three days, beginning from the time of the last feeding of ^{60}Co-containing insects. The total maximum radioactivity per pheasant was 0.084 μC/kg, and most ^{60}Co was present in liver, heart, and stomach. The specific radioactivity of liver, heart, and stomach greatly exceeded specific activity of trunk, limb, and wing muscles. The results show that treating Colorado beetles with $^{60}Co(NO_3)_2$ for ecological investigations does not contaminate the muscles of game bird in excess of acceptable doses when appropriate measures are observed. (BBB)

6472 ON THE RADIOACTIVE ISOTOPE UTILIZATION FOR FOREST PROTECTION. Popa, A.; Mihalache, Gh. Rev. Padurilor (Bucharest), 80: 59-62(Feb. 1965). (In Rumanian).

Some researches have been carried out on the Lymantria dispar fly control by irradiating their pupae with ^{60}Co sources. The analysis of the results shows that the ionized radiations emitted by ^{60}Co cause the Lymantria dispar pupae sterilization, the most convenient radiation dose being of 5000 R. During the tests performed in the laboratory and followed by larger experiences in different variants, it was found that the fecundity was reduced up to 50 per cent as against the control subjects in the variants where irradiated pupae have been introduced. The wider actions that were performed, destroyed nearly entirely some dangerous pests on rather large areas. (auth)

Genetics and Cytogenetics

Refer also to abstracts 6401, 6609, 6651, 6714, and 6731.

6473 (NYO-2902-5 (and Suppl.)) SOMATIC MUTATIONS IN THE MOTH EPHESTIA. Report on Research, August 1, 1965–September 15, 1966. Caspari, Ernst W. (Rochester Univ., N. Y.). Contract AT(30-1)-2902. 24p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The scales on the hind wings of 11 inbred Ephestia strains were compared to the standard strain NCR. Four of these strains, 2 wild type and 2 mutant strains, had strikingly different scale morphologies that can be easily distinguished from NCR and from each other. One of the strains, br, has scales of the hind wing that resemble one of the types induced on NCR wings by 5-bromodeoxyuridine (5-BDU). The strains BII and aaO that were made isogenic, except for the eye color gene a, by 67 generations of outcrossing differ in the morphology of the scales of their hind wings, indicating either that the mutant gene a has a pleiotropic effect on scale morphology, or that a gene affecting scale morphology is closely linked to it. Injections of tritiated thymidine into larvae 8 days after the last molt results in death within 6 hours when 2μc are injected. With 1μc some animals survive several days. Their wing buds become reduced in size and finally disappear. No mitosis or incorporation of tritiated thymidine was observed. At 0.5μc about two-thirds of the animals survive and pupate. The toxic effect seems to be due to the radioactivity of the tritiated thymidine, since equivalent amounts of non-radioactive thymidine are ineffective. The induction of mutations in Drosophila by injected 5-BDU is being investigated with the Müller-5 method. On the basis of the material available at the time of this report, 517 experimental and 286 control cultures, no mutagenic effect is indicated. Crosses involving the genes Rt (blue testes), rt (red testes) and br (brown eyes) were carried out. On the basis of these crosses it appears that br is either a third allele at the rt locus, in which case it should be designated as rt^{br}, or is very closely linked to it (at most 0.5 crossover units). Even in the latter case, the possibility of their constituting a functional genetic unit must be considered since both genes suppress the formation of ommin, though in different organs. The ommin was shown to be firmly bound to a protein in wild type (black) eyes. The oxygen uptake of normal Ephestia pupae of strain NCR was measured in a Warburg apparatus. The variability between individual pupae at the same age is very large. The reasons for this variability are discussed. It appears from the data, that the rate of oxygen uptake stays at a low level during the first five days after pupation, rises to a higher level at 6 days and stays at this plateau up to the 9th day. From the 10th day on the oxygen uptake rises, preparatory to hatching. (auth)

6474 GENETIC VARIATION IN THE GESTATION PERIOD OF SWINE. Cox, D. F. (Iowa State Univ., Ames). Contract AT(11-1)-707. J. Animal Sci., 23: 746-51(Aug. 1964).

The effects of x irradiation of the sire on the gestation periods in swine were studied by analysis of data taken from 1450 records on purebred Duroc and Hampshire sows maintained in a single herd. The distribution of the gestation period was leptokurtic. The gestation period in the Durocs was 0.5 day longer than in the Hampshires. The mean was 113.5 days. The heritability of the gestation period was 0.30 and repeatability, 0.42, based on an analysis of full sisters within the two breeds. Irradiation of the male parent had no significant effects either on litter size or gestation period of litters farrowed by their daughters. (C.H.)

6475 ERYTHROPOIETIC POLYPLOIDY. I. THE MORPHOLOGY OF POLYPLOID ERYTHROID ELEMENTS AND THEIR INCIDENCE IN HEALTHY SUBJECTS. Nemec, J.; Polak, H. (Research Inst. of Endocrinology, Prague). Folia Haematol. (Leipzig), 84: 24-40(1965).

The occurrence of polyploid erythroid elements in bone marrow smears of 15 healthy volunteers and of 71 patients with thyroid disorders and/or previous radiation exposure was ascertained. The multinuclear erythroblastic elements were in all cases the prevalent type of polyploid erythroid elements. In healthy persons the maximal occurrence of polyploid erythroblasts was 0.25%, with no other cells than binucleated ones. An index of erythropoietic polyploidy higher than 0.35% as well as the finding of erythroblasts with more than two nuclei and/or of pluripolar mitoses of erythroid series was considered to be a proof of an enhanced tendency to the formation of polyploid elements. Pluripolar mitoses were seen occasionally. They were never found in healthy subjects. Binucleated giant reticulum cells showing signs of phagocytosis were encountered occasionally, especially in patients with radiation damage. In normal marrow these cells were not found. Binucleated myeloid cells, said to be a sign of serious bone marrow impairment, were only exceptionally found in marrow smears of healthy subjects, and were more frequently encountered in subjects after irradiation. Their incidence was much lower than that of binucleated erythroblasts. The existence of an enzymatic mechanism inhibiting the formation and further division of polyploid erythroid elements is proposed. (TCO)

6476 EFFECT OF SELECTION ON WHAXY: AN AUTOSOMAL DOMINANT MUTATION IN THE SCREW-WORM FLY WITH RECESSIVE LETHAL EFFECTS. La Chance, Leo E.; Hopkins, D. E. (North Dakota Univ., Fargo). Amer. Natur., 99: 47-57 (Jan.-Feb. 1965).

The mutant Whaxy was originally described as one of several mutants in the screwworm fly, Cochliomyia hominivorax, induced by ^{60}Co γ radiation. Irradiation of a large number of flies was carried out in connection with a program of radioinduced sterilization of males for eradication of this fly. The mutation has now been under selection for more than 30 generations. The mutant flies are viable and their flight or other activity is not affected. In general, the data support the hypothesis that the Whaxy factor is dominant and lethal in the homozygous condition. However, after 22 generations of selection the number of Whaxy progeny in each generation increased significantly and has remained at a higher-than-expected level, assuming that the homozygous state continued to be lethal. Tests were conducted to investigate the possible reasons for the increase in Whaxy progeny. Data are presented on the hatchability of eggs, pupal emergence, and segregation of progeny from different crosses involving Whaxy flies. In the earlier generations crosses of Whaxy flies produced the expected 2 Whaxy : 1 normal progeny, and out-crosses produced the expected 50% Whaxy progeny. To explain the fact that after 22 generations of selection the number of Whaxy progeny in each generation increased significantly above 66% and remained at a level higher than expected, the possibility that selection resulted in a higher viability of the heterozygotes, survival of the homozygotes, or lower viability of the wild type is considered. Data from several experiments supporting one or the other alternatives are presented. The phenotype is due to a dominant autosomal mutation with recessive lethal effects. (BBB)

6477 MECHANISMS OF THE POSTRADIATION RECOVERY OF HEMATOGENIC TISSUE. Barakina, N. F.; Yanushevskaya, M. I. (Inst. of Animal Morphology, Moscow). Radiobiologiya, 6: 381-6(1966). (In Russian).

The number of chromosome aberrations in irradiated bone marrow cells after total or partial irradiation at a dose of 700 R does not differ appreciably within the first 48 hours. During the subsequent periods, the percentage of cells with chromosome damages in locally irradiated bone marrow decreases more rapidly than in the case of total influence of radiation at the same dose, approximately at the same rate as in the case of total irradiation at a dose of 400 R. In the shielded portions of the bone marrow, six hours after irradiation of other parts of the body, cells with chromosome damages in the form of chromosome and chromatid bridges are already appearing; their number (about 20%) remains at the same level in all the investigated periods. In the bone marrow of totally irradiated animals, cells with bridges appear in the first hours after irradiation; subsequently their number drops to normal. In the irradiated portions of the

bone marrow, when there are shielded portions of the hemopoietic system in the organism, cells with bridges are noted in the same numbers as in the shielded tissue. This fact may be explained by their migration from the nonirradiated portions of the hematogenic tissue. The absence of true chromosome rearrangements in the shielded bone marrow indicates that there is no migration of cells from the irradiated portions to the nonirradiated portions. (auth)

6478 HEMATOLOGICAL EFFECTS OF INTERNAL IRRADIATION WITH ^{32}P IN MICE. PART III. INFLUENCE ON THE OFFSPRING. Matsumoto, Hikoharu (Kyoto Univ.). Naika Hokan, 12: 37-45(Jan. 1965). (In Japanese).

Half of the first generation offspring which had been obtained by three combinations of matings between mice administered repeated small doses of ^{32}P and untreated controls were again given ^{32}P in the same dose (0.5 $\mu C/g$); then the F_2 offspring were produced by brother-sister matings. Thirty untreated mice of the first and second generation offspring and 11 ^{32}P-administered mice were followed by examining their peripheral blood picture periodically and were studied histologically after spontaneous death. In untreated mice, changes, such as transient or continuous anemia and thrombocytopenia and marked fluctuation of leucocyte count, particularly increased in intermediate forms of granulocytes at the time of leucocytosis, were observed. Also in untreated mice, the bone marrow showed a tendency toward the maturation arrest of the granulocytic series. One of the mice showed a myelogenous leukemoid reaction. At death, all of the ^{32}P-administered mice revealed hypoplastic hematopoietic tissue. (BBB)

6479 POLYCENTRIC CHROMOSOMES INDUCED BY X-RAYS IN GIANT CELLS OF CHINESE HAMSTER IN VITRO. Yu, C. K. (Argonne National Lab., Ill.). Chromosoma, 18: 60-9(1966).

After irradiation of cells in vitro some cells may continue to grow in size for a period equivalent to several normal generation cycles, then die. These giant cells show massive chromosome damage, such as multiple chromosome breaks. A detailed description is given of polycentric chromosomes induced by x irradiation in diploid cells. The cells received 250, 500, 1000, or 1500 R at a rate of about 110 R/minute after which they were sampled for cytological examination at 8, 14, 26, 50, 74, or 146 hours after irradiation. Radioinduced giant cells observed during interphase varied considerably in size. During mitosis, there were polyploid cells with up to more than 700 chromosomes (64N). Two types of polyploid cells were observed during mitosis: the true polyploidy type (its chromosomes already have been doubled or multiplied); and the endoreduplication type (with its doubled or multiplied individual chromosomes still side-by-side as in the diplochromosome configuration). Both types had massive chromosome aberrations, such as chromatid or chromosomal deletion. Both types of polycentric chromosomes were obtained with doses of more than 1000 R, generally between 26 and 74 hr. Chromosomal-type polycentric chromosomes in the simple chain form could be found in either diploid or polyploid cells. The induction of polycentric chromosomes by x rays supports a previous interpretation that at least some giant cells are polyploid cells that result from the repetition of endomitosis. (BBB)

6480 MUTATIONS CAUSED BY COSMIC RADIATION. Eugster, Jakob (Univ., Bern). Bild Wiss., No. 2, 26-34(1964). (In German).

The relations between mutations observed in crab eggs, grains, and human tissues following exposure to high energy cosmic irradiation are discussed. The experiments described demonstrate a definite mutagenic effect of cosmic radiation. The possibility is suggested that life on the earth arose from irradiation in a similar fashion of primary substances such as water, CO_2, methane, and ammonia, resulting in formation of complex organic molecules. The effects of irradiations on tissue depend on several factors, including the radiosensitivity, which is related to the rate of mitotic activity, regenerative capacity of the tissue, reserve capacity of the tissue that consists of the capacity of supplemental vessels and nerves to take over functions of damaged tissue, and genetic factors. The question of whether cosmic radiation has a mutagenic effect on plant and animal tissues was definitely established by studies made on experimental materials exposed for 72 hr to cosmic radiation during balloon ascents to 40 km. (BBB)

6481 MODERN GENETICS. VOLUME 2. Serra, J. A. London, Academic Press, 1966. 626p. $21.50. 135s.

Various aspects of physiological genetics are treated in this volume. Topics included are principles of gene action and phenogenesis, gene-controlled chemical reactions, cell differentiation and the phenogenesis of form characters, pleiotropy and lethal effects, allelic relations, environmental actions, gene interactions, dominance and superdominance, phenocopies, teratogenesis, pure lines and variability of genic effects, biometrical methods, quantitative characters, inbreeding and heterosis. (H.L.W.)

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Refer also to abstracts 5747, 5761, 5986, 6168, 6207, 6231, 6335, 6430, 6465, 6571, 6614, and 6661.

6482 (AD-636571) FEASIBILITY STUDY FOR A MOBILE LABORATORY TO EVALUATE ENVIRONMENTAL RADIATION CONTAMINATION. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Jan. 1966. Contract DA-49-146-XZ-257. 139p. (AFRRI-CR-66-1). CFSTI $4.00 cy, $1.00 mn.

Report originally issued May 1964.

A study of the laboratory requirements necessary for evaluating radioactive contamination of food, water and biological specimens was completed. From the information obtained, a mobile laboratory facility with the capability of qualitative and quantitative analyses of millimicrocurie amounts of alpha, beta and gamma emitting radioisotope contaminants was designed. The laboratory utilizes sufficient shielding so all analyses can be performed in a two mR/h gamma radiation field and where the average gamma energy is one MeV. The entire laboratory including all electronics, detectors, shielding, power supplies, motor generator, laboratory structure, and hardware, and transport container weighs less than two thousand pounds and has a total power requirement (115 volts ac–60 cycle) of four kilowatts. The laboratory in its cubic transport container, six feet on a side, is thus readily transportable either by helicopter or truck. From a review of the recent literature concerning radiation detection instruments, it is apparent that identification and quantitative evaluation of radioisotope contaminant constituents will require a standard sample size and counting geometry. All samples have thus been standardized to the dimensions and cylindrical geometry of a No. 10 food container. Reasonable detection efficiencies for alpha and beta counting are obtained by placing the detectors in intimate contact with the sample. Gross gamma counting is accomplished with a well-type plastic scintillator that is large enough to accommodate the entire No. 10 container. Alpha, beta, and gamma counting are carried out simultaneously using standard, transistorized, modular, commercial nuclear counting apparatus including single channel pulse height analyzers for limited energy discrimination. Identification of the gamma emitting contaminants is performed with a sodium iodide scintillation spectrometer and a commercial multichannel pulse height analyzer. All the detector systems are located inside the eight inch diameter, six feet long stainless steel canister. Radiochemical procedures require long times rather than elaborate equipment. Consequently, this form of isotopic analysis is not suggested for the purposes of the mobile laboratory. However, identification and quantitative estimation of contaminants in small volume biological specimens, such as blood, will require separation procedures, hence simple paper chromatographic analyses were recommended for use with the ultimate alpha, beta, or gamma counting to be performed with the canister detection system. Design costs in time and economic outlay are considered. (H.G.D.)

6483 (AD-637767) DATA PROCESSING FOR LOCAL CIVIL DEFENSE: AN INVESTIGATION OF THE POTENTIALS. Cusack, B. L. (System Development Corp., Santa Monica, Calif.). May 10, 1966. Contract OCD-PS-65-71. 61p. CFSTI $3.00 cy, $0.65 mn.

An investigation was made of the potential applications of electronic data-processing equipment for local civil defense functions. Directed specifically toward the viewpoint of the local civil defense director, the report presents the system considerations required to determine the time period(s) during which such equipments should be used; poses questions, gives answers and discusses the range of potential applications, the constraints and considerations of information systems, and management and operational factors; and, finally recommends the course of action to follow regarding further related studies. (auth)

6484 (AD-640810) MEASUREMENT OF TRITIUM SURFACE CONTAMINATION. Porter, S. W. Jr.; Slaback, L. A. Jr. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). July 1966. 18p. (AFRRI-SP-66-13; CONF-660403-4). CFSTI $1.00 cy, $0.50 mn.

From International Symposium on Radiological Protection of the Worker by the Design and Control of his Environment, Bournemouth, Eng.

Methods and techniques for measuring tritium surface contamination in reactor, accelerator, and tritium oxide environments are described. The problems associated with the presently used method of windowless flow proportional counting are discussed. A new method of utilizing special membrane swipe papers counted in a liquid scintillation system is described. The data from single channel and channel ratio liquid scintillation counting techniques, various swipe papers, and various tritium absorption agents are presented with a statistical analysis. Various factors affecting liquid scintillating counting of inorganic tritium are discussed. The

method gives approximately 20 percent efficiency with good statistics versus 1 percent efficiency and very poor counting statistics for flow proportional counting of tritium on swipe papers. From the standpoint of overall counting efficiency, reproducibility of counts, ease of counting, and physical strength, the vinyl membrane VM-1 paper counted in dioxane was found to be best for general tritium surface contamination measurements. (auth)

6485 (AD-641134) STRUCTURE SHIELDING FROM SIMULATED FALLOUT GAMMA RADIATION. Final Report: Phase II. Kaplan, A. L.; Waldman, J.; Koepp-Baker, N. B.; Barch, W. E.; MacNeil, R. L. (Technical Operations Research, Burlington, Mass.). June 1966. Contract N228-(62479)-65776. 86p. (TO-B-65-123; USNRDL-TRC-30). CFSTI $3.00 cy, $0.50 mn.

Two experiments were performed in this second phase of a study designed to evaluate the validity of the current structure shielding theory. The first experiment completed measurements begun earlier of in-and-down basement radiation. Here, the floor barrier reduction factor presently used to predict basement reduction factors theoretically was found to produce calculations lower, by a factor of between 1.5 and 7, then the experimental results. A new theoretical floor barrier reduction factor, which is a function of both the floor thickness and the solid angle fraction subtended at the detector by the floor, was constructed within the formalism of the existing structure shielding theory. This new function agrees quite well with both experimental results and Monte Carlo calculations, over the entire range of wall and floor thicknesses used in the experiment. The second experiment investigated the assumption that in evaluating the barrier reduction factor an inhomogeneous barrier can be treated theoretically as a homogeneous barrier of appropriate thickness. For the wall thicknesses, rib spacing, and rib size studied, this assumption was found to be quite satisfactory at distances behind the barrier larger than one-half the rib spacing. (auth)

6486 (BNWL-SA-918) TISSUE SAMPLING FOR PLUTONIUM THROUGH AN AUTOPSY PROGRAM. Newton, C. E. Jr.; Heid, K. R.; Larson, H. V.; Nelson, I. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 30, 1966. Contract AT(45-1)-1830. 15p. (CONF-661018-3). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 12th Annual Bioassay and Analytical Chemistry Meeting, Gatlinburg, Tenn.

Results are reported of a modest autopsy program started at Hanford Atomic Energy Plant in 1949 to obtain various tissue samples for Pu assessment from both former employees and residents. In all cases lung, liver, and bone samples were obtained, and lymph node samples have been collected routinely since 1960. Blood, pancreas, prostate and seminal vesicle samples were collected and analyzed intermittently. The radiochemical analyses of tissues from former Hanford plutonium workers showed that for a number of the former long-term Hanford employees, small but measurable internal depositions of Pu were found. Data obtained by autopsy allowed detection of Pu depositions not detectable with present bioassay surveillance techniques. However, sensitivity was insufficient for satisfactory results for bone and lymph nodes. Lungs and liver were the favored sites of deposition. (H.G.D.)

6487 (COO-1223-6) HYPOXIA AND PARA-AMINOPROPIOPHENOL AS RADIOPROTECTIVE AGENTS. Progress Report, July 15, 1965-May 31, 1966. Bonner, John F. Jr. (Indiana Univ., Indianapolis. Dept. of Biochemistry). June 1, 1966. Contract AT(11-1)-1223. 27p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

High pressure oxygen (3 to 4 atmospheres) does not reverse the action of typical chemical radioprotective agents (MEA, 5HT and PAPP). Damage in mice caused by exposure to high pressure oxygen appears to be additive to radiation injury. Experiments with metabolic inhibitors give no clues concerning the mechanism of radioprotective action of 5HT. Carbon dioxide (20%) in air has a small but significant radioprotective effect. The hypothesis is advanced that the radioprotective action of PAPP is caused by depletion of intracellular molecular oxygen when the PAPP is hydroxylated. The oxidized PAPP oxidizes the hemoglobin of red cells and is simultaneously reduced. The cycle continues until the PAPP is excreted (probably as the acetylated derivate) or is converted to another form that cannot take part in the cycle. (auth)

6488 (EGG-1183-2103) FISSION PRODUCT BETA-GAMMA COINCIDENCE COUNTING STUDIES. Number S-338-R. Michael, J. A.; Lamonds, H. A.; Story, E. J. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Aug. 1966. Contract AT(29-1)-1183. 42p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A generalized treatment of coincidence counting of radioactivity included within the air space between two opposing cylindrical detectors is given. Optimized geometries are considered. Expected counting rates, signal-to-noise ratios, and shielding requirements are determined for an assumed source of mixed fission product activity as a function of time after fission. Application to the Aerial Radiological Measuring System is discussed. (auth)

6489 (HASL-176) FLIGHT DATA AND RESULTS OF RADIOCHEMICAL ANALYSES OF FILTER SAMPLES COLLECTED DURING 1965. Thirteenth Progress Report on Project STARDUST. Feely, Herbert W.; Katzman, David; Biscaye, Pierre E.; Panaccione, John B.; French, Eugene R. (Isotopes, Inc., Westwood, N. J.). May 1, 1966. Contract DA-49-146-XZ-079. 89p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Flight data and results of radiochemical analyses of stratospheric and tropospheric air filter samples collected between January and December 1965 during Project Stardust are presented. Samples were analyzed for ^{90}Sr, ^{144}Ce, ^{137}Cs, ^{239}Pu, ^{238}Pu, ^{54}Mn, ^{109}Cd, ^{210}Po, and several products of cosmic ray activity including ^{7}Be and ^{32}P. Most of the sampler types used were calibrated by means of wind tunnel and/or in-flight studies. (H.G.D.)

6490 (ISO-SA-14) SEMI-REMOTELY MAINTAINED PLUTONIUM RECLAMATION FACILITY. Kesel, G. P.; Laws, R. B. (Isochem Inc., Richland, Wash.). July 8, 1966. Contract AT(45-1)-1851. 30p. (CONF-661001-15). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

For Presentation at 14th Conference on Remote Systems Technology, Pittsburgh, Pa.

The Plutonium Reclamation Facility, built at the Richland Operation in 1964, utilized a semi-remotely maintained facility concept and other unique features in its design. Equipment containing large radiation sources is confined to a concrete cell and mounted on dunnage with plugs that match holes in the walls. Vessel piping and electrical leads pass through the plugs and terminate in a stainless steel-faced glove box. Personnel are thus exposed to only limited radiation from small diameter interconnecting piping, valves, pumps, controllers, etc., housed in the glove box. Operation and maintenance experience has demonstrated the soundness of the design concepts. (auth)

6491 (NYO-3364-26) CONTINUATION OF THE INVESTIGATION OF NORWEGIAN SCHOOL CHILDREN WITH REGARD TO THEIR BODY BURDEN OF ^{137}Cs DUE TO RADIOACTIVE FALLOUT. Madshus, Kjell (Norsk Hydro's Inst. for Cancer Research, Oslo); Stroemme, Aksel (Norsk Radiumhospital, Oslo). [1966]. Contract AT(30-1)-3364. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Potassium content, height, weight, and body surface were measured and related to the ^{137}Cs body burden in Norwegian children averaging 15 years of age. Body content of potassium was higher in boys than in girls. The over-all trend in ^{137}Cs body burdens was a steady decrease that was more pronounced during winter months. A greater decrease in ^{137}Cs concentrations was observed in milk during the same period. (H.G.D.)

6492 (ORNL-P-2568) CALCULATION OF RADIATION DOSE DUE TO HIGH-ENERGY PROTONS. Wright, Harvel; Branstetter, E. E.; Neufeld, Jacob; Turner, J. E.; Snyder, W. S. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 18p. (CONF-660920-11). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy.

Results are presented that were obtained in a continuing study of the dosimetry of high-energy protons. Studies in high-energy proton dosimetry are of interest in assessing the potential radiation hazards for manned space flight and are also of interest for radiological protection in the vicinity of high-energy accelerators and for biological irradiation experiments. The present calculations consider the dose deposited in tissue by protons with energies from 400 MeV to 2 GeV. Some of the results dealing with the dose due to protons with energies up to 400 MeV were reported previously. For proton energies below 400 MeV, the production of pions in the cascade process was not sufficiently common to be considered significant. However, in the present calculations it is necessary to take pions into account. The basic quantity of interest in dosimetry is the absorbed dose, defined in units of the rad where 1 rad is equal to 100 ergs/gram. In order to calculate the dose equivalent, one specifies a quality factor (QF) which is often related to the values of linear energy transfer (LET) at which the energy deposition takes place. This QF-LET relation is then used to determine the dose equivalent. The dose and dose equivalent was calculated in each sub-slab of a phantom having the form of a slab 30 cm thick and infinite in lateral extent. Computer calculations were made to provide absorbed dose and dose equivalent data. (C.H.)

6493 (ORNL-P-2709) DISTRIBUTION OF DOSE IN THE BODY FROM A SOURCE OF GAMMA RAYS DISTRIBUTED UNIFORMLY IN AN ORGAN. Fisher, H. L. Jr.; Snyder, W. S. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26.

41p. (CONF-660920-10). Dep. mn. CFSTI $3.00 cy, $0.65 mn.
From 1st International Congress of the International Radiation Protection Assn., Rome, Italy.

A Monte-Carlo-type calculation was used to estimate the dose in 22 organs and 100 subregions of an adult human phantom for four initial γ energies. It appears that a Monte Carlo method of estimating organ doses is feasible under certain conditions. Doses determined in a homogeneous tissue phantom give results that may be extrapolated to many real situations. Gamma sources were located internally. (H.G.D.)

6494 (ORNL-TM-1531(Pt.1)) CIVIL DEFENSE RESEARCH PROJECT ANNUAL PROGRESS REPORT, MARCH 1965-MARCH 1966. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 189p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on various aspects of civil defense including biomedical aspects, sociological aspects, and protective systems. Biomedical studies were conducted on contamination of foodstuffs, physiology of heat stress, the Punkah-Pump, and the hazards of nuclear warfare to sheltered populations. Sociological research included strategic interaction, dynamics of American national security attitudes, determinants of influentials' responses to communications about a negative contingency, and emergency planning and urban problems. Protective systems were considered for blast and shock waves, thermal threat to sheltered populations, and urban protection. (H.G.D.)

6495 (TID-23286) SURVEILLANCE NETWORKS, REVISION NO. 1. Allen, Robert E. (comp.) (Division of Operational Safety (AEC), Washington, D. C. Nuclear Explosives Environmental Safety Branch). June 1966. 101p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A reference document was compiled to serve as a summary of the major radiation surveillance and monitoring programs within the USA, Canada, and Mexico. Sampling procedures and areas of interest of the various networks are discussed. (H.G.D.)

6496 (UCRL-50050-1) RELATIVE SIGNIFICANCE INDEX OF RADIONUCLIDES FOR CANAL STUDIES. James, Ralph A.; Fleming, Edward H. Jr. (California Univ., Livermore, Lawrence Radiation Lab.). Sept. 13, 1966. Contract W-7405-eng-48. 10p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A method is presented for arranging the radionuclides in the order of decreasing relative significance. In the current absence of sufficient data to do otherwise, it is assumed temporarily that the fraction, k, of each nuclide existing in the environment ingested per day is constant. The value of k for each nuclide that gives the maximum allowable dose suggested for the general public by the ICRP thus allows arranging the nuclides in the order of their significance. The relative significance index in terms of decreasing significance includes (in this order): $^{90}Sr-^{90}Y$, ^{210}Pb + chain, $^{137}Cs-^{137m}Ba$, $^{106}Ru-^{106}Rh$, ^{185}W, ^{181}W, ^{144}Ce, ^{54}Mn, ^{55}Fe, ^{45}Ca, ^{89}Sr, ^{91}Y, ^{147}Pm, ^{22}Na, $^{95}Zr-^{95m}Nb$, $^{103}Ru-^{103}Rh$, ^{59}Fe, ^{141}Ce, $^{125}Sb-^{125m}Te$, $^{129}Te-^{129m}Te$, ^{155}Cu, $^{131}I-^{131m}Xe$, $^{140}Ba-^{140}La$, ^{32}P, and ^{143}Pr. (H.G.D.)

6497 (AEC-tr-6828) EVALUATION OF RADIOACTIVE AEROSOLS. [PART] I. Inouye, Takeichiro Translated from Kuki Seijo, 3: No. 4, 26-31(1965). 15p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Potential hazards from the inhalation of radioactive aerosols are discussed. Data are summarized on the content and activity of decay products from naturally occurring Rn and ^{220}Rn in the atmosphere in various parts of the world and the content of ^{90}Sr, ^{239}Pu, and gross β activity in the atmosphere as a result of nuclear weapons tests. Possible sources of atmospheric contamination during the handling and processing of radioactive materials or from nuclear accidents are discussed. The 1958 and 1962 recommendations of the ICRP for maximum permissible concentrations of biologically important radioactive aerosols in various tissues are included. (C.H.)

6498 MEASUREMENT OF PATIENT DOSE IN X-RAY DIAGNOSIS. Bunde, E.; Pychlau, P. (Univ., Munich). Radiologe, 4: 367-72(Nov. 1964). (In German).

It cannot be claimed that the biologically effective irradiation burden of a patient can be exactly ascertained from a knowledge of the surface dose and energy of radiation that a patient receives. However, the use of as many measurements for dose control as possible in x-ray diagnosis has important advantages and no disadvantages. All of the measurement equipment available for control of irradiation exposure has four properties in common: The instruments include a proportional portion of the surface area of the beam that is used to irradiate the patient; the measurement recorded uses the air ionization produced by the x rays in a manner similar to the way that ionization chambers are used clinically during radiotherapy; the measurement device placed in the radiation beam is located apart from the patient; and the measurement results are expressed in the form of unique count values. The ionization chambers used are generally flat, and located transversely to the direction of the radiation beam, with relatively large shielded openings so that their ionization volume varies proportionately with the cross section of the radiation beam. The results obtained are compared to those of a dosimeter; the charge can be expressed in terms of R-cm^2. The ionization current is proportional both to the dose potential and the beam cross section. The product of the two is independent of the distance as long as the cross section of the beam is not greater than the cross section of the sensitive chamber volume. This permits the chamber to be mounted directly onto the x-ray machine. (BBB)

6499 PRACTICAL WATER PHANTOM. Winkler, Norlin T. (Mayo Clinic, Rochester, Minn.). Radiol. Technol., 35: 65-71 (Sept. 1963).

A practical water phantom is described which is built from inexpensive materials readily available to most x-ray departments. A filling and emptying system permits control of the water depth to the nearest millimeter. Use of the water phantom for various test purposes and in the improvement of x-ray techniques is described. Various tests may be made by repeated exposures with varying techniques on patients until roentgenograms of acceptable diagnostic quality result, but this method should be avoided whenever possible because of the radiation hazard to the patients. Also, because of individual variations in patients, accurate information is difficult to obtain. Initial testing to determine exposure changes needed is better done by using a phantom. The water phantom was used to provide a source of scattered radiation and as an absorber of primary radiation to produce roentgenograms with densities that could be read with a densitometer. As another example, the water phantom was used in conjunction with a commercial pelvic phantom containing human bone. When the water phantom was placed over the pelvic phantom, roentgenograms made of this combination of pelvic phantom and water phantom, with varying amounts of water in the water phantom, are comparable to those obtained of patients of various sizes. It was also used to compare relative film speeds, to find changes in exposure necessary for changing to faster screens, and to transfer x-ray exposure techniques from a stationary x-ray machine to a mobile unit. (BBB)

6500 IS AN X-RAY EXAMINATION DANGEROUS? Pape, R. (Wilhelminenspital, Vienna). Wien. Klin. Wochensch., 77: 518-21 (July 23, 1965). (In German).

The author discusses the risks of radiation injury from fluoroscopy and x-ray examinations. These include the gonadal dose as a function of dose administered to several points of the body for men and women, including the head and extremities, thorax, and upper and lower abdomen. Calculated and measured gonadal doses are compared for x-ray photography and fluoroscopy of the chest, stomach, in irrigoscopy, and for pyelography. The comparative values were very similar. Differences in the frequency of x-ray studies of the head, extremities, chest, and abdomen for children, young adults, and adults are listed and compared. In general, the gonadal dose varies between 1 and 100% of the applied dose, or from ~0.01 to several R. It is necessary to ensure that all x-ray studies are carried out with the least possible irradiation dose, particularly in persons less than 30 yr old. (BBB)

6501 AN EVALUATION OF U_3O_8 EXPOSURE WITH AN ESTIMATE OF SYSTEMIC BODY BURDEN. Scott, L. M.; West, C. M. (Union Carbide Corp., Oak Ridge, Tenn.). Health Phys., 13: 21-6(Jan. 1967). (Y-KB-57).

The complete personnel monitoring data for an employee exposed to U_3O_8 enriched to approximately 90 percent ^{235}U are evaluated. Three component exponential models are fit to both urinalysis and in vivo monitoring data. Biological half-life estimates range from 7 days for the fast component to over 200 days for the long term component. A power function having a slope of -1.5 also fits the data after 10 days. Fecal sampling initiated 8 days after secession of the exposure showed insignificant levels in comparison to urine and was discontinued. Total urinary excretion is approximately 36,000 pCi lower than original burden as estimated by in vivo monitoring. It is concluded that this discrepancy can be explained either by elimination via the feces or translocation to the bone. An estimate of systemic body burden is made from the data. (auth)

6502 URINALYSIS FOR ^{235}U AND ^{238}U BY NEUTRON ACTIVATION ANALYSIS. Kramer, Henry H.; Molinski, Victor J.; Nass, Harold W. (Union Carbide Corp., Tuxedo, N. Y.). Health Phys., 13: 27-30(Jan. 1967).

A rapid neutron activation analysis method was developed to determine concentrations of ^{235}U and/or ^{238}U in urine down to 0.1 μg/l, $\frac{1}{50}$ of the lowest suggested investigation level for either isotope. (auth)

6503 WHOLE-BODY COUNTERS IN ROUTINE MONITORING. Vennart, J. (Radiological Protection Service, Sutton, Eng.). Health Phys., 13: 61-72(Jan. 1967).

The principal use of whole-body counters in routine monitoring for body radioactivity, should be to detect those occasional accidental intakes of radioactive material which are greater than significant levels. A significant activity, A μCi, is taken to be one-tenth the quarterly limit on intake resulting from continuous exposure to MPC_w or MPC_a recommended by ICRP. A figure of merit related to the γ-rays escaping from the body and the difficulty of measuring them, is derived which is equal to the product of A and the number, N, of γ-rays emitted with energies greater than 100 keV per disintegration of the radionuclide, i.e., AN γ-ray μCi. About 85 percent of the 111 radionuclides considered have values of AN which are greater than 0.1 γ-ray μCi, many greatly in excess of this value. Activities in the body of this magnitude may be measured by quite simple equipment. This is fortunate because many of these radionuclides have short residence times in the body and monitoring must be done at frequent intervals, preferably at the place of work. It is concluded that there is scope for the development of a simple whole-body counter for routine use and that there are few radionuclides for which the setting up of high sensitivity whole-body counters is justified. The use of high sensitivity equipment is best limited to a few specialist centers having the necessary qualified personnel and facilities which are required to make best use of the equipment. (auth)

6504 TWO INCIDENTS INVOLVING EXPOSURE OF DENTISTS TO IONIZING RADIATION. Fleischmann, A. W. (New South Wales Dept. of Public Health, Sydney). Austral. Dental J., 10: 434(Dec. 1965).

Two incidents are reported in which high film-badge exposures lead to investigations that, in one case, will save the dentist concerned much cost in a reduced number of fogged films and, in both cases, will lead to considerably less radiation dose to the operator of the x-ray unit. The two incidents emphasize that, while most film badge results are negative, their use is still justified by the occasional detection of potentially hazardous faults in equipment. (TSS)

6505 LYMPHOCYTES AS INDEX OF RADIATION. Brit. Med. J., 1: 372-3(Feb. 12, 1966).

By a technique of culturing leukocytes and inducing mitosis, chromosome changes induced by irradiation can be detected. Problems in the use of the method are discussed. (TSS)

6506 DESIGN AND EVALUATION OF A FREE AIR IONIZATION CHAMBER FOR GRENZ-RAY MEASUREMENTS. Clifton, J. S.; Goodchild, D. T.; Martin, S. J.; Osborn, S. B. (University Coll. Hospital, London). Brit. J. Radiol., 39: 693-5(Sept. 1966).

The design characteristics of a compact free-air ionization chamber, for use with x rays generated from 10 to 50 kVp, are discussed. It is shown that its sensitivity does not vary in this range by more than 3 percent. Used in conjunction with a transistorised electrometer, rates from 0 to 10,000 R/minute can be measured. (auth)

6507 SHIELDED CONTAINER FOR CARRYING AND DISPENSING DOSES OF RADIOISOTOPES FOR INTRAVENOUS USE. Bell, T. K; McKittrick, N. (Royal Victoria Hospital, Belfast). J. Med. Lab. Technol., 22: 226-7(Oct. 1965).

A lead pot of $2\frac{3}{4}$ in. OD and walls $\frac{1}{2}$ in. thick, which surrounds columns of ^{132}Te received in the lab from the supplier, forms the basic part of the container which is designed to accommodate bijou bottles of 6-ml capacity. The pot, which has a lid $\frac{1}{2}$ in. thick, is reduced to $3\frac{1}{2}$ in. high and two slots $1\frac{1}{4}$ in. long and $\frac{1}{4}$ in. wide, directly opposite each other are cut in its surface $3\frac{1}{8}$ in. from the bottom. A hollow cylinder of lead, $2\frac{1}{2}$ in. long and walls $\frac{1}{4}$ in. thick inserted in the container, is kept in place by two screws which hold an aluminum handle for carrying the dispenser. The bijou bottle is supported at the bottom by a plastic sponge and is surrounded by a cylinder of cardboard to minimize mechanical shock. The metal top of the bottle is perforated by a $\frac{5}{16}$ in. dia hole near the edge and the radioactive solution retained by a rubber bung. The container is held in the inverted position by a retort stand and clamp when dispensing the doses and the bottle is kept in place by an L-shaped piece of lead $3\frac{1}{2}$ in. long and $\frac{1}{4}$ in. thick placed in the slots. A hole in this L-piece $\frac{5}{8}$ in. dia centered on the hole in the top of the bijou bottle allows it to be cleaned before removing the radioactive doses with a syringe. The container, which may be used for carrying and dispensing tracer doses of ^{131}I labeled substances for renal function and cerebral blood flow studies, attenuates the γ radiation emitted by this isotope by over 95%. Unused doses may be resterilized by placing the whole container in an autoclave without removing the bottle. (BBB)

6508 IMPORTANCE OF THE DIRECT RETENTION AND OF THE PRODUCTIVITY OF PASTURES IN THE CONTAMINATION OF MILK BY RADIOACTIVE FALLOUT. Kirchmann, R. J.; Boulenger, R. R. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Mededel. Landbouwhogeschool Opzoekingssta. Staat Gent, 30: 1227-40(1965). (In French).

Experiments on the contamination of pastures by radioactive fallout under field conditions are described for the period from 1958 to 1963. Various factors which influence the transfer of the following fallout radionuclides to milk were examined: ^{90}Sr, ^{131}I, ^{137}Cs, ^{103}Ru, ^{95}Zr–^{95}Nb, ^{141}Ce, and ^{147}Nd. The effects of the nature of the vegetation, its density, and rainfall were examined particularly. The study included a control field, covered with a polyethylene sheet, and thus uncontaminated with radionuclides. For ^{90}Sr a direct proportionality was found between the radioactivity of rainfall and that of the above-ground parts of ryegrass and clover. For ^{90}Sr and ^{131}I, the results also showed that contamination of milk is directly related to the contamination of grass (expressed as activity per dry weight). In a region where fallout occurs homogeneously, the level of the contamination of the milk is determined by the yield of the pastures and is higher in areas where the yield is lower. Different plant species, used for cattle feeding, are compared with respect to their retention of fission products from fallout. A monthly record is given of ^{90}Sr contamination of pastures and milk in the Mol area from 1958 to 1963. (BBB)

6509 RADIOACTIVITY IN PHOSPHATE ANIMAL FEED AND FERTILIZERS. Habashi, Fathi (Montana Coll. of Mineral Science and Technology, Butte). J. Ass. Offic. Anal. Chem., 49: 944-5(Oct. 1966).

Commercially available defluorinated phosphate and dicalcium phosphates marketed as animal feed contain 0.01 to 0.02% uranium. If an animal is fed 1 lb of this material, a dose of about 0.17 microcurie will be given, which is about 20 times the maximum permissible limit. It is pointed out that such cattle feeds may be hazardous to man. (H.G.D.)

6510 THE PROPERTIES OF $MgSO_4$:Mn THERMOLUMINESCENCE DOSIMETERS. Ichikawa, Yoneta (Nara Gakugei Univ., Japan). Nara Gakugei Daigaku Kujo, 14: 13-18(Feb. 1966). (In Japanese).

Experiments with $MgSO_4$: Mn thermoluminescent dosimeters are reported. The sample for the study was prepared by heating a mixture of $MgSO_4 : 2H_2O$ and $MnSO_4 : H_2O$ to 1000°C. In the glow curve of $MgSO_4$: Mn, the luminescence glow reached the maximum at about 85°C, 120°C, and 250°C. The response of these glow peaks was linear up to 2400 mR. The decay rates of the peaks at 85°C and 120°C were about 6% and 5% per hr, respectively at 7°C. The decay of the 250°C peak was very small; less than 25% was lost during the first 24 hours. The peaks at 85°C and 250°C showed the maximum sensitivity to the radiation when the sample was prepared 2.5 mole % mixture of $MnSO_4 : H_2O$ and that of 120°C did the same at 1 mole % mixture. Thus it was found that this dosimeter detected a dose as low as 5 mR. Furthermore, it was observed that the peak at 250°C showed very high sensitivity for triboluminescence. (auth)

6511 BETA IRRADIATION OF THE CONJUNCTIVAL SAC: DESCRIPTION OF A NEW APPLICATOR. Lederman, M. (Royal Marsden Hospital, London); Jones, C. H. Brit. J. Radiol., 39: 867-9(Nov. 1966).

A radiation detection instrument designed for intracavitary use is described. The instrument has several advantages over previously reported instruments. Being battery operated, the anesthetic explosion hazard resulting from external power requirements has been eliminated. The need for an auxiliary readout device is not necessary; the physician is therefore able to make measurements without assistance. The probe is lightweight and can easily be transported for use in the operating room or the patient's room. The amplifier section of the probe, which is completely transistorized, has displayed excellent stability. Direct current drift of the instrument is less than 2% of full scale per day. The response of the amplifier is limited only by the meter movement. By using solid state circuitry there is no warm-up period, very little power is required, and microphonic effects have been eliminated. The instrument was used routinely for intracavitary measurements over a period of 16 months and proved to be a definite advance over other types of probes used in this application. (auth)

6512 FAST-NEUTRON DOSE WEIGHTING FACTORS FOR MAN RATED SNAP REACTORS. Spangler, G. W.; Willis, C. A. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 359-60(Oct.–Nov. 1966).

6513 TISSUE CURRENT-TO-DOSE CONVERSION FACTORS FOR NEUTRONS WITH ENERGIES FROM 0.5 TO 60 Mev. Irving,

D. C.; Alsmiller, R. G. Jr.; Moran, H. S. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 359(Oct.–Nov. 1966).

6514 PHYSICAL AND BIOLOGICAL DOSE CALCULATIONS FOR PROTON AND ALPHA FLUXES INCIDENT ON A SHIELDED-MAN MODEL. Hill, C. W.; Simpson, K. M. Jr.; Ritchie, W. B. (Lockheed Georgia Co., Marietta). Trans. Amer. Nucl. Soc., 9: 360-1(Oct.–Nov. 1966).

6515 NEW TECHNIQUE FOR THE COMPUTER REPRESENTATION OF THE HUMAN BODY. Guber, Walter; Mittelman, Phillip S. (Mathematical Applications Group, Inc., Hartsdale, N. Y.). Trans. Amer. Nucl. Soc., 9: 358(Oct.–Nov. 1966).

6516 DEPTH DOSE CALCULATIONS IN AN EVALUATION OF FALLOUT SIMULATORS AND FALLOUT FIELDS. Garrett, C. W. (Air Force Radiobiological Research Inst., Bethesda, Md.); French, R. L. Trans. Amer. Nucl. Soc., 9: 357-8(Oct.–Nov. 1966).

6517 DOSE AND DOSE-EFFECT RELATIONSHIP MODIFYING FACTORS IN PREDICTING THE DEGREE OF BIOLOGICAL RESPONSE. Bond, V. P. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 358(Oct.–Nov. 1966).

6518 DISTRIBUTION OF DOSE AND DOSE EQUIVALENT IN AN ANTHROPOMORPHIC PHANTOM RESULTING FROM BROAD-BEAM SOURCES OF MONOENERGETIC NEUTRONS. Snyder, W. S.; Auxier, J. A.; Brown, M. D.; Jones, T. D.; Boughner, R. T. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 357(Oct.–Nov. 1966).

6519 RATIONALE OF RADIATION PROTECTION. Rossi, Harald H. (Columbia Univ., New York). Trans. Amer. Nucl. Soc., 9: 357(Oct.–Nov. 1966).

6520 CALCULATIONS OF RADIATION HAZARD DUE TO EXPOSURE OF SUPERSONIC AIRCRAFT TO SOLAR-FLARE PROTONS. Leimdorfer, M. (Research Inst. of National Defense, Stockholm); Alsmiller, R. G. Jr.; Boughner, R. T. Trans. Amer. Nucl. Soc., 9: 335-6(Oct.–Nov. 1966).

6521 PROBABALISTIC TREATMENT FOR EVALUATING AEROSPACE NUCLEAR SAFETY. Ruwe, Dean M.; Anderson, Denton C. (Martin Co., Baltimore). Trans. Amer. Nucl. Soc., 9: 323(Oct.–Nov. 1966).

6522 DIRECT INTRAURETERAL DOSIMETRY IN TELECOBALT THERAPY FOR CERVIX CANCER. Huellemann, R.; Maus, H. J.; Adler, H. (Univ.-Frauenklinik, Hamburg). Arch. Gynaekol., 202: 325-8(1965). (In German).

The problem of estimation of the spatial dose distribution in combined Ra-telecobalt treatment is still unsolved. Measurements were made with Ca fluorescence dosimeters implanted in the ureters at a point ~2 cm above the ureteral ostium. Irradiation administered consisted of 2 abdominal and 2 dorsal fields, with a focal dose of 100 R or 200 R to the parametrium. The central beam was directed ~10° toward the pelvis. Measurement results, with a ±10% error were obtained from 13 patients, of whom 10 received 200 R doses and 3 received 100 R doses. For the first group the measured doses in the right ureter ranged from 159 to 207 R, and in the left ureter from 147 to 219 R. In the second group the measured doses in the right ureter ranged from 72 to 99 R, and from 91 to 112 R in the left ureter. The values measured indicated that the dosimeters were located within the 50% isodose region of the usable radiation beam. Lateral shifts of the irradiation fields cannot definitely be avoided with stationary fields, so that different lateral irradiation of the ureters may result, especially in adipose women. The results obtained indicated that various doses may be produced during stationary field telecobalt irradiation, apparently depending on the topography of the pelvic organs in the juxtavesicular region of the ureters. These discrepancies may be greater for intrauterine implanted Ra. (BBB)

6523 PROBLEM OF RADIOACTIVE MINERAL WATERS FROM THE HYGIENIC POINT OF VIEW. Talenti, M.; Cigna, A. (Univ., Rome). Nuovi Ann. Ig. Microbiol., 15: 568-71(Nov.-Dec. 1964). (In Italian).

Radioactive waters are defined in Italy as those which contain more than 4 nCi/l; more exactly, weakly active waters contain 1–30 nCi/l; active waters contain 30–150 nCi/l; strongly active waters contain more than 150 nCi/l. Other classifications based on Ra content are discussed. The basis of determinations on ^{222}Rn and ^{226}Ra is outlined. Previous measurements on Italian waters in general have been carried out with inadequate equipment for distinguishing the contributions from these isotopes. The scintillation chamber appears to be adapted particularly well to the determination of ^{222}Rn in equilibrium with ^{226}Ra, as distinguished from excess ^{222}Rn. The max admissible concentration of ^{226}Ra in water is 1 pCi/l; avoidance of continued use of more active waters is suggested. This value for the general population may be altered by recent studies on the ratio between Ra content in water and in the human body. Contributions of each nuclide to total activity of Italian mineral waters will be studied in the future. (BBB)

6524 RADIOPROTECTIVE SULFANILAMIDES. Lazanyi, A. (Centrul de Cercetari Biologice, Cluj); Uray, Z.; Hollan, T.; Jagamos, M. Naturwissenschaften, 53: 502-3(1966).

Each of six sulfanilamide compounds was injected intraperitoneally into mice 20 min prior to whole-body x irradiation. Sulfoguanidine and sulfamethoxypyridazine had a radiosensitizing effect. The following compounds had a radioprotective effect: sulfathiazole, sulfanilamide, sulfathiocarbamide, sulfamethazine. (H.L.W.)

6525 CONTRIBUTION TO RADIATION PROTECTION IN ACCIDENT SURGERY. Klatnek, Norbert (Arbeitsunfallkrankenhaus, Graz). Arch. Orthopaed. Unfallchir., 57: 129-32(Jan. 4, 1965). (In German).

Radioprotective techniques and devices used in this lab include film dosimeters, an image intensifier-television viewer arrangement, remote control devices for positioning film cassettes, and extension tables. Exposure time for personnel is minimized wherever possible. To protect the patient from over-exposure as much as possible the area to be photographed is marked out beforehand, and the position of central beam predetermined. The beam is focused precisely, and standardized, highly sensitive film is used. Rubberized Pb plates are used for protection of the gonads when photographs of the pelvic area are taken. (BBB)

6526 RECENT RESULTS ON THE INJURY FROM IONIZING RADIATION ON THE BASIS OF MODERN CONCEPTS OF DOSIMETRY. Vallebona, A. (Univ., Genoa). pp 161-70 of XII Convengo della Salute, Ferrara, May 15-16, 1965. Modena, Stabilimento Poligrafico Artioli, 1965. (In Italian).

Methods are considered for calculating radiotherapy dose to provide a maximum tumor dose while sparing healthy tissues of excessive exposure. The concept of the chronologic distribution of the dose is emphasized. A system is proposed that results in calculation of a value of R per day, which is in turn related to the biodose. Biodose is defined by the expression: (tissue chronodose/days)/(erythema chronodose/days) = tissue biodose. Various pathologic effects can be expected at certain biodose levels; for example, radioinduced nephritis results when the biodose exceeds 0.85 (equivalent to 2210 R fractionated over 30 days). Spacial aspects of dosimetry are also considered, and isobiodose curves are illustrated. (TSS)

6527 CIVIL DEFENSE IN A NUCLEAR AGE. LIVING AND NURSING IN A FALLOUT SHELTER. Eicherly, Elizabeth E. (Harrisburg Hospital School of Nursing, Pa.). Amer. J. Nursing, 65: 123-5(Nov. 1965).

Some medical problems that may arise during confinement in a fallout shelter are enumerated and means whereby nursing care can overcome them are mentioned. Some individuals will be unable to withstand the pressure and to retain self-control and the ability to function intelligently during the emergency. Within an hour or so after entering a shelter, the body temperature of many individuals will rise several degrees due to excitement, the elevation of room temperature, and the physical activity of a number of people working in a confined area. Their temperatures usually will return to normal within 12 to 24 hours. During the first day or two of shelter occupancy, many persons may develop headaches. Inadequate ventilation also may cause some persons to experience lightheadedness or actual dizziness. Some of the occupants may develop diarrhea and nausea, due to fright, excitement, anxiety, and the hyperactivity of the individual prior to shelter occupancy. Some problems which arose during several simulated shelter stays, in which small groups of persons lived for several days in an area providing 10 ft^2 of space per person, are presented. Some of the common medical emergencies which will arise during a shelter stay are described. (BBB)

6528 CIVIL DEFENSE IN A NUCLEAR AGE: PREPAREDNESS MAY MEAN SURVIVAL. Sullivan, Catherine M. (Office of the Surgeon General, Washington, D. C.). Amer. J. Nursing, 65: 121-3(Nov. 1965).

Responsibilities of nurses in caring for casualties during and after a thermonuclear attack are outlined. Medical care in fallout shelters will have the primary objective of providing survival care for the sick and injured and employing measures to prevent the spread of disease. If no physician is present, nurses will be responsible for caring for the sick and injured. The postattack program is planned to provide medical care to the sick and injured of the surviving population emerging from the shelters. Such a program can go into effect only after fallout radiation has decayed to a safe level. In the postshelter period, with the establishment of emergency medical and health services, nursing functions and

responsibilities will broaden and increase. At this time the Packaged Disaster Hospital would become operational. In the postattack period, it is assumed, the normal incidence of illness will increase greatly because of a breakdown or deterioration of the environmental factors which control the peacetime health status. (BBB)

6529 RADIONUCLIDES IN SELECTED HUMAN TISSUES. Baratta, E. J.; Ferri, E. S. (Public Health Service, Winchester, Mass.). Amer. Ind. Hyg. Ass. J., 27: 438-43(Sept.-Oct. 1966).

The concentrations of strontium-90, cesium-137, and polonium-210 in various human tissues have been measured at the Northeastern Radiological Health Laboratory since 1965. The greatest concentration of cesium-137 was found in the psoas muscle. The "soft tissue" concentration of strontium-90 was highest in psoas muscle of males, but this tissue contained the lowest concentration for females. The highest concentration of polonium-210 was observed in the liver. In general, higher concentrations of this radionuclide were observed in organs from smokers than in those from nonsmokers. Comparison of the relative distribution of radionuclides observed in this study with the values used in computing maximum permissible concentrations for radiation workers revealed a number of differences. On this basis it would appear that considerably more effort is required on the determination of the body distribution of the more common radionuclides being ingested by the population today. (auth)

6530 USES AND SAFETY ASPECTS OF THE LOW-ENERGY SOURCE ^{169}Yb. Green, Farno L. (Viso Corp., Burlington, Mass.). Amer. Ind. Hyg. Ass. J., 27: 444-8(Sept.-Oct. 1966).

The radioactive source ytterbium-169 emits a 52-keV characteristic x ray and various gamma rays with energies from 65 keV to 310 keV. Ytterbium sources in small exposure units weighing about 20 pounds are useful for radiography of castings, weldments, assemblies, and other forms of various materials, such as aluminum, magnesium, iron, plastics, and wood. Radiography with ^{169}Yb produces no hazard from electrical shock or explosion. Radiation scattered from air, the object, and surrounding materials is less with ^{169}Yb than with conventional x-ray sources, ^{192}Ir, or ^{60}Co. Therefore, portable radiographic applications can be made with less difficulty in protection of personnel. (auth)

6531 TOTAL β ACTIVITY IN TEETH OF CATTLE OF VARIOUS AGE GROUPS. Giese, W.; Harry, K. P.; Prinz, W. (Tieraerztliche Hochschule, Hanover). Zentralbl. Veterinaermed., 12: 587-91(Dec. 1965). (In German).

Measurements of radioactivity of the incisor teeth of 380 cattle in Northern Germany showed that the older animals had lower β activity/g Ca than the younger ones. The average concentration ranged from 40.9 ± 3.6 pCi/g Ca in animals 0.5 yr old to 18.5 ± 2.8 pCi/g Ca in animals 9 to 10 yr old. A comparison of the values for teeth produced between 1953 and 1963 with the mean values for ^{90}Sr concentrations in milk during these same yr showed a statistically significant correlation in the radioactivity curves. Thus the radioactivity concentrated in teeth was dependent on the degree of fallout at the time of their formation, indicating that most of the β radiation in teeth comes from ^{90}Sr. Studies indicated further that ~78% of the activity measured was precipitable by oxalate, which showed that the ^{90}Sr activity/g Ca was slightly higher in cattle than in human teeth. Because of their smaller absorption and shorter half lives ^{89}Sr, ^{140}Ba, ^{144}Ce, ^{95}Zr, and ^{234}Th probably formed only a very small part of the activity measured. (BBB)

6532 COMPUTATION OF DOSAGE IN INTERSTITIAL AND INTRACAVITARY RADIATION THERAPY. Shalek, Robert J.; Stovall, Marilyn (Univ. of Texas, Houston). J. Chron. Dis., 19: 519-22(Apr. 1966).

The use of computers to calculate radiation doses with sealed sources is explained. Computer methods used with implantations of radioactive seeds or needles permit the description of the full radiation distributions resulting from a particular geometry of sources. Since the placement of sources in the patient is never exactly as planned, the calculations of the dose distributions are most useful when they are based upon the array of sources as they exist in the individual patient. Radiographs of radium needle implants are used to ascertain the geometrical relation between the sources. Thus, it seems likely that the added dosimetric information supplied by the computer calculations for interstitial implantations will be effective in improving treatment and avoiding radioinduced injuries. (BBB)

6533 RADIATION DOSAGE IN MASS RADIOGRAPHY. Watson, J. (Birmingham Chest Radiology Center, Eng.). Radiography, 32: 42(Feb. 1966).

Comments are made on an earlier report on mass radiography dosage, in which it was stated that there is only one way that the mass x-ray unit can reduce the dose to an amount equivalent to that given by a hospital apparatus for chest radiography. The report then described a Bouwers mirror optical system with a small light intensifier tube which has a high amplifying factor. It is suggested that, using a 2-mm aluminium filter, the mean skin dose would be ~300 mR without such a device. Dose levels are tabulated that were recorded using a Bouwers mirror optical system both 100 mm and 70 mm. The results were obtained with a green-sensitive screen and green-sensitive film and judicious use of wetting agent added to the developing solution with time and temperature technique. A small capful of wetting agent added to 80 oz of a developing solution at given time and temperature reduced the exposure by 0.01 sec to achieve the same density factor. Hence, 200 ml are added to 10 gal working strength developer. Central skin doses were 0.015 R with large films and 0.108 R and 0.117 R on small films with the 70 and 100 mm optical systems, respectively. Corresponding ovarian doses were 0.078, 0.14, and 0.26 mR whereas male gonad doses were not measurable. These measurements were made with the E.1.1 electrometer and 35 cm^3 chamber. The ovary doses were calculated from the measured posterior surface dose by using the conversion factor 0.26. The kilovoltages (95 to 125 kv) were the highest which would normally be used in examinations. (BBB)

6534 LEGAL CONSIDERATIONS ON IONIZING RADIATION. Radionuclides and Radiation Emitting Devices. Hutton, Gerald L. Springfield, Ill., Charles C. Thomas Publisher, 1966. 98p. $5.50.

Basic nuclear science is reviewed as a background for discussions of the legal aspects of atomic energy. Legal concepts considered in view of radioactivity and hazards therefrom include: statutes of limitation, proof of actionable radiation injury, res ipsa loquitur, malpractice, third party liability of manufactures and suppliers of nuclear products, and civil aspects of regulatory and statutory standards. (H.G.D.)

6535 CALCULATION OF THE SPATIAL DISTRIBUTION OF FAST AND INTERMEDIATE NEUTRON DOSE IN A TISSUE-EQUIVALENT HUMAN PHANTOM. Prokofeva, Z. A.; Zolotukhin, V. G.; Obaturov, G. M. Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-76/57, 18p. (In Russian). (CONF-660807-29). ORAU.

From Symposium on Neutron Monitoring for Radiological Protection, Vienna.

Results are presented of a Monte Carlo calculation of spatial distributions of the doses of scattered charged particles from neutrons of the following energies: 10, 7.5, 5.0, 2.5, 1.0, 0.5 MeV, 20 keV, 5 keV and 100 eV. The phantom was regarded as an infinite elliptical cylinder with semi-axes of 18 and 12 cm, arbitrarily positioned in a plane-parallel flux of monoenergetic neutrons. In the calculation the composition of the phantom was regarded as a homogeneous mixture of hydrogen nuclei (6.15×10^{22} nuclei/cm^3) and oxygen (3.465×10^{22} nuclei/cm^3). The nuclear density of oxygen actually includes nuclei of oxygen, nitrogen, and carbon, since their nuclear constants are sufficiently close under the conditions considered. The method of calculation used is based on averaging the collision contribution to the dose, as described by Snyder and Neufeld. A double distribution was calculated for the doses of scattered protons and recoil nuclei for two fixed directions of neutron flux perpendicular to the axis of the cylinder—parallel to the minor and major axes of the ellipse in the cross-section of the phantom. Results are given for each dose component and for 264 sectors formed by the intersections of 12 polar radii and 22 elliptical arcs. The distribution is obtained from these data using a Snyder and Neufeld calculation. The insignificant discrepancy is satisfactorily explained by the difference in the constants used and the different geometrical conditions. The data can also be used to calculate the absorbed neutron doses to the critical organs of man and the average dose to the body under more realistic conditions than with the slab approximation. (auth)

6536 ILLINOIS: FIRST STATE TO MAKE PERSONNEL MONITORING AND REPORTING COMPULSORY. Stratton, Leroy E. 12p. (CONF-660606-34). ORAU. Gmelin, AED-CONF-66-203-58.

From American Nuclear Society Meeting, Denver, Colo.

Implementation of the Illinois Radiation Monitoring Act is discussed. Enacted in 1963, the law requires that: a type of personnel monitoring service be provided radiation workers by employers; the records be maintained and a copy submitted to the Department of Public Health; and commercial film badge services be approved by the Department. Similarities to federal legislation sponsored by the USAEC are pointed out. (H.G.D.)

6537 URINARY PHOSPHATE RESPONSE AS A BIODOSIMETER. Musgrove, William S.; Sprague, Edwin B. (Boeing Co., Seattle). 14p. (CONF-660621–23). ORAU. Gmelin, AED-CONF-66-193-25.

From Health Physics Society, 11th Annual Meeting, Houston, Tex.

Work with urinary phosphate changes following radiation has been performed in an attempt to establish a biodosimeter technique. Charles River, CD, 200 gram, male rats were used. The animals were kept and the experiment performed in a relatively stress-free environment. The rats were given approximately 100 rads of cobalt-60 radiation per day and the individual urinary phosphates were measured each day, using a modified Fiske–Subbarow procedure. Daily phosphates were compared to the individual's pre-irradiation level. Thus, the change in phosphate excretion was measured and compared with controls. The individual excretion curve was then plotted. In cases of daily radiation to death, it was found that individuals in a group demonstrated susceptibility variation representing as much as a factor of three from dosage for most susceptible to least susceptible. The individual excretion curves were cubic in nature. At lower daily dosage, the roots of the curve are real and at higher daily dosage, two imaginary roots are obtained. The second differential of the equation of the curve, or acceleration, is a straight line with positive slope. As long as the acceleration is negative, the dosage is sub-lethal; when the acceleration is positive, the dosage is lethal. (auth)

6538 CALCULATION OF THE RADIATION DOSE RESULTING FROM NATURAL AND ARTIFICIAL RADIOACTIVE ISOTOPES IN THE GROUND BY GAMMA-RAY SPECTROMETRY. Keil, R. A.; Franke, Th. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). 10p. (CONF-747–9). ORAU.

From 4th Symposium on Radioactivity in Scandinavia, Riso, Denmark, Oct. 5-6, 1964.

By means of gamma spectrometry artificial radiation components (i.e., that of fallout depositions) can be separated from the natural ambient radiation resulting from the natural radioisotopes in the ground. A 4.5″ × 2″ NaJ(Tl) scintillation crystal and a multichannel analyzer installed in a vehicle were used to study these problems and to estimate the dose rates from natural and artificial radiation fields. Two different methods were developed to obtain total dose rates as well as dose rates from single radioisotopes. The first method uses the calculation of total energy absorbed in the NaJ(Tl) scintillator. The relation between absorbed dose in rad and exposure dose in roentgen is shown. The second method uses the area under the total absorption peak that is proportional to the primary flux of photons of specific energy at the detector. The calibration was carried out by point and plane standard sources of different gamma ray energies between 100 keV and 1.8 MeV. If angular response of the detector on soil depth distribution of the nuclides is taken into account, dose rates can be estimated within an error of 10 to 20% as shown in the region of 0.01 to 50 μR/h. (auth)

6539 A SUMMARY OF EXPOSURES TO THE OFF-SITE POPULATION AS A RESULT OF NUCLEAR REACTOR TESTS CONDUCTED AT THE NUCLEAR ROCKET DEVELOPMENT STATION DURING 1965. Oakley, Donald T. 9p. (CONF-660621-16). ORAU. Gmelin, AED-CONF-66-193-11.

From Health Physics Society, 11th Annual Meeting, Houston, Tex.

A summary of whole body and thyroid exposures resulting from five nuclear reactor experiments conducted at NRDS during 1965 is presented. The exposures are compared with protection standards and it is shown that the exposures are small compared to the standards. (auth)

6540 THE CONTRIBUTION OF INTERMEDIATE ENERGY NEUTRONS TO THE NEUTRON DOSE EQUIVALENT OUTSIDE THE SHIELDING OF REACTORS AND HIGH ENERGY ACCELERATORS. Nachtigall, D. (EURATOM, Geel, Belg.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-76/62, 6p. (CONF-660807-27). ORAU.

From Symposium on Neutron Monitoring for Radiological Protection, Vienna.

The contribution of intermediate energy neutrons to the neutron dose equivalent outside the shielding of reactors and high-energy accelerators was measured using a difference method. The results indicate that intermediate energy neutrons sometimes may contribute the major portion to the neutron dose equivalent and that, in general, only dosimeters which cover the intermediate energy range and which are independent on special spectral distributions should be used. (auth)

6541 CALCULATIONS OF KERMA DUE TO FAST NEUTRONS IN TISSUE-LIKE MATERIALS. Williamson, Frank S.; Mitacek, Paul Jr. (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-76/15, 12p. (CONF-660807-36). ORAU.

From Symposium on Neutron Monitoring for Radiological Protection, Vienna.

Revised calculations were made of the KERMA for unit fluence of neutrons in the energy range 0.1 to 10.0 MeV for pure hydrogen, carbon, nitrogen, and oxygen. The information was transferred to computer data cards so that the effect of any type of neutron spectrum on any tissue-like material can be calculated rapidly. Curves of KERMA versus neutron energy are presented for the average tissue composition of Standard man and KERMA/Fluence data are included for four hydrogeneous compositions commonly employed in neutron dosimetry, carbon dioxide, and argon. (C.H.)

6542 APPARATUS FOR RADIOACTIVE DECONTAMINATION OF WATER. Bovard, P.; Grauby, A. (to Commissariat a l'Energie Atomique). Canadian Patent 744,352. Oct. 11, 1966. Priority date June 21, 1963, France.

Filtration using the properties of certain porous media for removing the radioactive elements and electrolysis to isolate substances not retained by filtration are the methods used in this separation. The device is portable in the form of a column and handles about one liter per hour for a minimum of ten days before cleaning or renewal of the filters is needed. Clays, resins or activated carbon constitute the porous materials. A bacterial filter may be added if required. (F.S.A.)

Medicine

Refer also to abstracts 6446, 6498, 6499, 6507, 6517, 6522, 6532, 6533, 6628, 6642, 6645, 6673–6675, and 6695.

6543 (NYO-2455-21) TUMOR LOCALIZATION WITH RADIOISOTOPES. Final Report, September 1, 1959–August 31, 1966. Bender, Merrill A. (Roswell Park Memorial Inst., Buffalo, N. Y.). Sept. 29, 1966. Contract AT(30-1)-2455. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Achievements during the contract period are summarized. Mercury-203-labeled neohydrin was proven to be clinically effective for the detection of brain tumors; ^{75}Se-selenomethionine was developed for pancreatic visualization; and ^{18}F as the fluoride ions was shown to be effective in the early detection of primary and metastatic bone tumors. Success of the analog version of the Autofluoroscope in routine scanning procedures is reported. References to 20 papers and reports published during the contract period are included. (H.G.D.)

6544 PLUTONIUM EXCRETION FOLLOWING CONTAMINATED ACID BURNS AND PROMPT DTPA TREATMENTS. Lagerquist, C. R.; Allen, I. B.; Holman, K. L. (Dow Chemical Co., Golden, Colo.). Health Phys., 13: 1-4(Jan. 1967).

Diethylenetriaminepentaacetic acid (DTPA) treatments were given to an employee exposed to plutonium via a contaminated nitric acid burn. The treatments were given promptly and repeated daily for 27 days. A total of 210,000 dpm of plutonium was eliminated in the urine in the first 60 days after the accident. This represents 96.5 percent of the amount taken into the system, assuming that the amount remaining is excreted according to the Langham equation. The case is similar to an exposure that occurred at Rocky Flats a year previously. In both cases, a sum of two exponentials expresses the daily plutonium excretion in the urine over the first 60 days. (auth)

6545 WHOLE-BODY COUNTERS. Remenchik, Alexander P. (Stritch School of Medicine, Hines, Ill.); Miller, Charles E. J. Amer. Med. Ass., 197: 117(July 4, 1966).

The construction, operating characteristics, and applications of whole-body counters are briefly commented on. Two principal types of whole-body counters have been developed. One uses a sodium iodide crystal as a radiation detector, and in the other the subject is surrounded by a tank of liquid which acts as the radiation detector. While the energy resolution (ability to discriminate between γ rays of slightly different energies) of sodium iodide crystal counters is high, their sensitivity (percent of emitted γ rays detected) is relatively low. Conversely, liquid counters have poor energy resolution, but are characterized by high sensitivity. Although the sensitivity and calibration of all current counters depends on body composition and configuration, the effects of these limitations may be minimized. Applications made of these devices fall, generally, into three categories: radiation-protection monitoring, natural potassium measurements, and low-level tracer work. Their use in radiation-protection monitoring is described. Prevention and control of unnecessary occupational exposures depends upon the capability of recognizing and assessing incident or increasing body burdens of radioactive materials. Levels of radioactivity 1/1000 of the recommended maximum permissible body burdens are readily detected by whole-body counters. Furthermore, certain contaminants may be retained in the body and excreted at exceedingly low levels. Under these circumstances only a whole-body counter would indicate the presence of these

radioactive contaminants in the body. Low-level tracer work represents the greatest potential application of whole-body counters in clinical medicine. Metabolic studies have been simplified considerably by the application of whole-body counters to the study of human disease. Now it is possible to measure directly the percentage of an oral test dose of radioactive material absorbed and retained within the body. This technique permits absorption and turnover studies of radioactive isotopes in outpatients. (BBB)

6546 RAPID PLOTTING AND RECORDING OF RADIOISOTOPES WITH THE GAMMA-RETINA DEVICE. Schumacher, G. (Technische Hochschule, Aachen). Elektromedizin, 9: 161-5 (Sept. 1964). (In German).

A new development of electronic equipment for recording and plotting the spatial and temporal distribution and movement of radioisotopes in organs and tissues is described. The apparatus consists of an assembly of counters that simultaneously detect radioisotope concentrations in a manner similar to the autofluoroscope. Each detector is backed up by a preamplifier, discriminator, pulse shaper, pulse integrator, and a final stage. The output can be used to modulate the intensity of a light source. The pattern of the light sources thus will indicate the pattern of radioisotope concentrations measured. The display can be photographed. An additional development of this equipment is described which includes a display of the output on an oscilloscope screen. A drive oscillator produces a pulse train that drives two staircase generators. These produce a raster on the oscilloscope screen. The brightness of the raster points are controlled by the outputs of the radioisotope detectors. The counters are serially coupled to the brightness control circuit by a ring counter. To evaluate the pulses from each detector the output pulses charge a condensor. The ring counter discharges a condenser when the cathode ray reaches the point on the screen assigned to the particular detector. The height of the discharge pulse is proportional to the number of quanta recorded between two images on the screen. The arrangement of the detectors can be altered, to some degree, to suit the radioactive object that is to be studied. Block diagrams, photographs and results obtained in bronchography, angiocardiography, a heart model, and a model of peripheral venous circulation are presented. (BBB)

6547 RADIOPROTECTIVE ACTIVITY OF TRIAMMONIUM 2-DITHIOCARBAMOYL-3-DITHIOCARBONYLTHIOPROPANOATE. Wang, Richard I. H. (Marquette Univ., Milwaukee); Dooley, William Jr.; Foye, William O.; Mickles, James. J. Med. Chem., 9: 394-6(May 1966).

Trithiocarbonate zwitterions of 2-mercaptoethylamine, 2-mercaptoethylguanidine, and related compounds are effective as radiation protective agents, but have limited solubility in water and appreciable toxicity. Therefore, a compound without these disadvantages was sought in the trithiocarbonate of cysteine. A dithiocarbamate of cystine was prepared, but had no appreciable antiradiation properties. Treatment of cysteine with carbon disulfide and ammonium hydroxide in the usual manner gave only products of indefinite composition. Use of reaction conditions that avoided an excess of base did, however, provide the dithiocarbamate thithiocarbonate of cysteine (DTC) as the triammonium salt. Use of ethanol as solvent with dry ammonia also produced this compound in much better yield. The radiation protective ability and toxicity of DTC in mice were determined, and the comparative value of this compound with that of 2-aminoethylisothiouronium bromide hydrobromide (AET) presented. DTC was one-half to one-third less toxic to mice than AET. DTC appeared to be slightly less effective than AET, although 20 μmole of DTC or AET offered similar protection to mice exposed to 800 R. The advantage of DTC over AET is noticeable when good protection to 800 R is obtainable at nontoxic concentrations of DTC in the chemical mixture containing 2 μmole of serotonin and 25 μmole of MEA. At 1100 R, a chemical mixture with AET at 5 or 10 μmole was distinctively more effective than that of equimolar concentration of DTC in similar mixture. However, when the concentrations of DTC in the chemical mixture were increased to 20 and 30 μmole, good protection (33 and 75% survival, respectively) was achieved with minimal increase in chemical toxicity. It is concluded that good protection against the lethal effects of ionizing radiation can be obtained by using a compound such as DTC which is less toxic than AET. (BBB)

6548 PLACENTAL LOCALIZATION USING RADIOACTIVE ISOTOPES. Hibbard, Bryan M. (Univ. of Liverpool). Clin. Obstet. Gynecol., 9: 93-113(Mar. 1966).

Advantages and disadvantages of using radioisotopes for placental localization are considered. The radiation dose delivered by various isotope preparations was evaluated, and it was found that all compare favorably with the dose from x-ray placentography. Clinical experience with radioiodinated serum albumin (RISA) showed that whole-body radiation is slight, but the metabolic degradation of albumin results in the slow release of ^{131}I in a free form. As a result, ^{131}I crosses the placental membrane and is taken up by the fetal thyroid and will be excreted in the milk of a breast-feeding mother if the pregnancy terminates shortly after injection of the isotopes. Use of ^{132}I-RISA is proposed as a means of reducing the radiation hazard. It is concluded that radioisotope methods for determining the placental site are simple, accurate, and safe providing care is taken in choice of materials. (TSS)

6549 MEASUREMENT OF THE EFFECTIVENESS OF PLATELET TRANSFUSIONS. Cronkite, Eugene P. (Brookhaven National Lab., Upton, N. Y.). Transfusion, 6: 18-22(Jan.-Feb. 1966). (BNL-9646).

The importance of platelet transfusions in thrombocytopenia and hemorrhage is discussed. The use of carbon-14 labeled serotonin to determine platelet life span is described. The use of platelet life span measurements to determine effectiveness of platelet transfusions is discussed. The value of determining red cell mass using chromium-51 is discussed. Experiments were performed with paired irradiated dogs: one member of the pair received platelet transfusions and the other received no therapy. It was demonstrated that fresh platelet transfusions prevented bleeding in the fatally irradiated dog. The clinical evaluation of the effectiveness of platelet transfusions is discussed. Two cases of thrombocytopenia in humans are described. When platelet transfusions were given there was marked improvement in both cases. (H.L.W.)

6550 RADIOIMMUNOASSAY FOR ALPHA MELANOCYTE STIMULATING HORMONE. Ross, G. T.; Odell, W. D.; Goodfriend, T. (National Institutes of Health, Bethesda, Md.). Proc. Soc. Exp. Biol. Med., 123: 218-20(Oct. 1966).

A radioimmunoassay has been developed for alpha melanocyte stimulating hormone (α MSH). The assay compares favorably with biologic assays in terms of sensitivity and appears to be better in terms of precision and specificity. (auth)

6551 STUDY OF THE PROTECTING EFFECT OF CHLOROQUIN ADMINISTERED TO GUINEA PIGS SUFFERING FROM SKIN DISEASES CAUSED BY X-RAY IRRADIATION. Bielicky, Tibor; Zak, Miroslav; Bartak, Pavel; Malina, Lubor (Charles Univ., Prague). Voj. Zdravot. Listy, 34: 261-3(Dec. 1965). (In Czech).

Chloroquin has a good effect in healing injuries caused by irradiation; an effect that is dose dependent. Best results were obtained when the drug was administered 2 hours before irradiation. The drug stimulates the activity of the pentose cycle. It maintains the SH groups in a reduced state, reduces folic acid to tetrahydrofolic acid, thereby making possible the synthesis of purines and pyrimidines, and it stimulates the formation of lipids and phospholipids. It is assumed that every factor stimulating pentose activity helps in skin regeneration. (J PRS)

6552 COMPARATIVE EVALUATION OF THE PROTECTIVE ACTIVITY OF POTENTIAL RADIOPROTECTIVE AGENTS (BUNTE SALTS) ON VARIOUS BIOLOGICAL MODELS. Kudryashov, Yu. B.; Kakushkina, M. L.; Mekhtieva, S. M.; Rachinskii, F. Yu.; Sumarukov, G. V.; Filenko, O. F. (Moscow State Univ.). Radiobiologiya, 6: 272-7(1966). (In Russian).

It has been postulated that the aminoalkylthiosulfuric acids or Bunte salts can be hydrolized in vivo to yield radioprotective aminoalkylthiols. In order to confirm this and develop a means of testing potential radioprotective agents against in vitro models, the activity of 7 of these salts was compared with that of 3 known radioprotective agents in male white mice irradiated with 200 to 1000 rad, and in intact human erythrocytes, haploid yeast cells (Zygosaccharomyces bailii), or solutions of β-carotene irradiated with 1000 rad/min. The protective agents were injected intraperitoneally 25 to 30 min before irradiation or added to the suspension 1 to 5 min before irradiation or addition of a radiomimetic agent. The results indicate that compounds can be tested for radioprotective activity in in vitro systems, but that prolonged contact is required. (auth)

6553 PEGGED KILOVOLT TECHNIQUE. Funke, Thomas (Picker X-Ray Corp., Cleveland). Radiol. Technol., 37: 202-13 (Jan. 1966).

Use of pegged kilovolt technique to improve radiograph quality while reducing patient exposure is discussed. In pegged kilovolt radiography each projection is assigned kilovoltage and milliampere-second values appropriate to a body part of average thickness. The recommended kilovoltage is used whenever practical (the milliampere seconds are varied with the thickness) so that radiographic contrast is maintained as consistent as possible. With the kilovoltage pegged at the proper level, the milliampere seconds are used to control radiation quantity so that the film is properly exposed no matter what the thickness of the part. Higher kilovoltages permit the use of shorter exposure times;

reduce the entrance dose, integral dose, and gonad dose to the patient, and deliver less heat to the target of the x-ray tube. The pegged kilovolt step chosen for each projection should provide the most satisfactory contrast which can be attained with reasonably small tube loading, patient dose, and exposure times. Low kilovolt steps are preferred in radiography of the distal extremities and whenever contrast must be enhanced. High kilovoltages may be used when tube loading or radiation exposure must be reduced, or when they furnish the most desirable contrast. A dark radiograph is difficult to interpret on an ordinary illuminator, indicates unnecessary radiation exposure and additional tube loading, and does not exhibit higher contrast except in direct exposures. Beyond certain limits it becomes impractical to increase the milliampere seconds further because the limits of safe tube loading or acceptable exposure times cannot be exceeded. (BBB)

6554 INFILTRATION OF THE PARAMETRIUM BY ACTINOMYCOSIS FOLLOWING SURGERY AND RADIATION OF CERVIX CARCINOMA. Moebius, W. (Friedrich-Schiller-Univ., Jena, Ger.). Arch. Geschwulstforsch., 22: 7-13(1963). (In German).

Two yr following surgery and postoperative irradiation of a stage II uterine squamous cell carcinoma with focal doses of 2469 R to the right and left parametrium, a patient developed a rigid, nodular infiltration in the treated area. A yr after this the patient lost considerable weight and appeared to be in poor physical condition. A firm infiltrate was detected in the left parametrium. The vagina and the vaginal stump were entirely smooth. The patient was given a second, intensive, fractionated x irradiation, with a focal dose of 3204 R right and left. This treatment had only slight effect on the infiltration. Subsequently, a biopsy of the affected area which had developed an ulcerated area showed histologically an inflamed, vascularized granulation tissue, with a colony of actinomyces. The patient continued to lose weight and the infiltrate became more compact and increased in size. After combined treatment with 6-sulfanilamido-2,4-dimethylpyrimidine (aristamide) and pyrimethamine (daraprim) the infiltrate regressed and the patient's general condition improved. A second treatment series resulted in complete disappearance of the infiltrate. This case indicates that actinomycosis should be considered when genital carcinomas are treated similarly. Irradiation treatment had very little effect on the actinomycosis. (BBB)

6555 RADIATION ACCIDENT AT HAMMERSMITH. Brit. Med. J., 233(July 23, 1966).

Three patients at the Hammersmith Hospital (London) received an overdose of electrons while being treated from the hospital's 8-MeV linear accelerator. It was concluded that the accident was due to a very rare combination of circumstances: an irregularity of current that occurred about once a year for a few days, and a simultaneous failure of the dosimeter, not immediately noticeable. (TSS)

6556 SPECIFIC CHEMOCIDAL THERAPY. Costello, Cyril (Washington Univ. Medical School, St. Louis). Missouri Med., 59: 418; 424(May 1962).

Use of a specific labeled compound to be incorporated into carcinoid tumor and thereby destroy tumor cells by radiation was explored. Tracer studies indicated that 60% of dietary tryptophan is converted to 5-hydroxyindole in patients with carcinomas, while the remaining dietary tryptophan is presumably utilized in the normal production of body protein and niacin. The studies stimulated consideration of possible methods of interfering with the cellular metabolism based on the predilection by the carcinoid tumor for dietary tryptophan. Accordingly, trace doses of radioactive tryptophan (DL-tryptophan-2-^{14}C) were fed to a patient with advanced carcinoid disease. A rapid turnover rate indicated that it was unlikely that cellular destruction could be effected by radioactivity. Further investigation disclosed that tryptophan analogs could be synthesized that were more potent in radioactivity than the DL-tryptophan originally used. Results suggested that a higher concentration of specific activity might be obtained by using radiofluorine-labeled 5-fluorotryptophan, and that feeding such material to a patient with extensive metastases could possibly produce cancericidal destruction. (TSS)

6557 SURVEY OF RADIOISOTOPE CAMERAS. Anger, Hal O. (Univ. of California, Berkeley). ISA (Instrum. Soc. Amer.) Trans., 5: 311-34(Oct. 1966).

Radioisotope cameras are relatively new instruments for imaging the distribution of γ-ray or positron emitting isotopes in vivo. The higher speed of cameras over scanners permits taking sequences of still pictures of time-lapse motion pictures to show the movement of isotopes in physiological processes. When a large enough quantity of activity is used, exposure times can be as short as 1 sec. The various types of γ-ray image detectors used in radioisotope cameras are described in this article. Image-forming collimators for use with γ-ray emitters and coincidence collimation methods for use with annihilation radiation from positron emitters are discussed. Methods are described for obtaining optimum images and the quantitative value of the amount of isotope present in a given picture area as a function of time. (auth)

6558 RADIOACTIVE AGENTS FOR THE DELINEATION OF BODY ORGANS BY EXTERNAL IMAGING DEVICES. A REVIEW. McAfee, John G.; Subramanian, Gopal (State Univ. of New York, Syracuse). ISA (Instrum. Soc. Amer.) Trans., 5: 349-72(Oct. 1966).

Within the past decade, many new compounds labeled with gamma-emitting radionuclides have been developed for the visualization of various organs of the body by scintillation scanning or stationary camera techniques. Although the development of radiopharmaceuticals is still in its infancy, and undergoing rapid change, its importance in the diagnosis of human diseases is already well established. The physical and chemical properties of radioactive agents are significantly different from those of stable drugs. Of particular importance for imaging applications are compounds of ^{131}I, ^{51}Cr, ^{197}Hg, ^{75}Se, radioactive bone-seekers, radiocolloids, and various radioactive agents for brain tumor localization. Recently, short-lived radionuclides available from radioisotopic chromatographic columns have attracted considerable interest, and compounds with different tissue-localizing properties are being labeled with these materials. (auth)

6559 COMBINED RADIATION AND SURGICAL MANAGEMENT OF CANCER. Watson, T. A. (Univ. of Western Ontario, London). J. Can. Ass. Radiol., 17: 162-6(Sept. 1966).

Considerable interest is being shown in various combinations of radiation and surgery in the treatment of cancer, in the hope of improving the overall results in certain sites. The use of postoperative radiotherapy is quite well established and routine in the management of some tumors. The main controversy and renewed interest surrounds the use of preoperative irradiation. It is agreed that, with modern supervoltage techniques, delayed operative healing, or other postoperative complications, are not increased in number. The indications for such management, the dosage, protraction and fractionation of such irradiation, and the delay that is advisable between radiation and surgery, are by no means settled. It would seem that preoperative radiotherapy is valuable in certain situations, but high dosage must be used. There is no convincing evidence that low dose preoperative irradiation is effective from either animal or human studies. Since, however, significant improvements in cure rates are unlikely as a result of advances in technique, either in surgery or radiotherapy, it is reasonable to explore combinations of the two methods in the hope of an additive effect. (TSS)

6560 REPAIR OF POTENTIALLY LETHAL DAMAGE IN X-IRRADIATED HeLa CELLS. Phillips, R. A.; Tolmach, L. J. (Washington Univ., St. Louis). Radiat. Res., 29: 413-32(Nov. 1966).

Treatment of synchronous populations of HeLa S3 cells with the DNA inhibitors fluorodeoxyuridine or hydroxyurea immediately after irradiation with 220-kV x rays in the dose range 300 to 600 rads causes a decrease in the fraction of surviving cells. Postirradiation incubation at 29°C produces a similar result. Cells show quantitatively similar responses to these treatments throughout G_1, their capacity to respond persisting for about 5 hours after irradiation. The effect of temperature and hydroxyurea increases with the duration of treatment up to at least 12 hours. None of the treatments affects the viability of unirradiated cells. It is postulated that these treatments inhibit a process, ordinarily operating in irradiated cells, whereby potentially lethal damage is repaired. This repair process may involve some type of DNA synthesis. The relation of the presumptive potentially lethal damage to sublethal damage is unknown. In contrast, cycloheximide, an inhibitor of protein synthesis, increases survival when administered to cultures after irradiation; it apparently enhances the repair process, perhaps by inhibiting a competing process by which the potentially lethal damage is ordinarily expressed in the cell. In addition, the increase in survival brought about by treatment with cycloheximide is greater in cells irradiated in late G_1 than in cells exposed in early G_1. This suggests that the increase in radiation sensitivity accompanying progression of cells of this strain through G_1 is the result of an increasingly favorable outcome of the expression process as compared to the repair process. (auth)

6561 PREVENTION OF COMPLICATIONS IN THE CANALICULUS LACRIMALIS IN X RAY THERAPY OF SKIN CANCER OF THE INTERNAL ANGLE OF THE EYE. Brovkina, A. F.; Kostyukova, T. D. Med. Radiol., No. 8, 28-33(1966). (In Russian).

An analysis of the causes the lacrimation occurring after x ray

therapy for skin cancer of the internal angle demonstrates that the greatest number of complications develops as the result of cicatricial closure of the canaliculus lacrimalis and its mouth. In connection with the above-said the authors propose a method of prophylaxis of these complications. In the process of x ray therapy into the inferior canaliculus lacrimalis one introduces a biologically inactive polychlorvinyl tube, which remains in the canaliculus during the entire period of radium treatment. There occurs no functional disturbance of lacrimation. The referred to technique of introducing a tube was tested in 60 patients. In all the cases a stable positive effect was achieved. Notwithstanding irradiation of canaliculi in a dose of 6,000 to 10,000 rad the patency remains unchanged. The introduction of the tube is a sufficient prophylactic measure against lacrimation which, however, impedes the working capacity. (auth)

6562 EFFECTS OF SOME RADIOPROTECTIVE SUBSTANCES UPON PRE-NATAL SURVIVAL OF OFFSPRING TO ROENTGEN IRRADIATED MALE MICE. Froelen, H. (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Radiol. Therapy, Phys., Biol., 4: 373-84(Oct. 1966).

Genetic effects of x-irradiation, determined as the rate of intrauterine death of offspring from irradiated male mice, was studied in matings within the first week (spermatozoa) and the third week (spermatids) after exposure. Of cysteamine, AET, cystamine, glutathione, and serotonin, only cysteamine clearly reduced mutations in the irradiated spermatids and spermatozoa. (H.G.D.)

6563 DOSE DISTRIBUTION STUDIES IN EXTERNAL IRRADIATION OF CARCINOMA COLLI UTERI. Ranudd, Nils Erik (Karolinska Sjukhuset, Stockholm). Acta Radiol. Therapy, Phys., Biol., 4: 353-62(Oct. 1966).

Various techniques for the external irradiation of cervical carcinoma are discussed and illustrated by dose distribution in two or three planes. For external irradiation of patients who have received intracavity radium application, a technique with three beams is proposed. Advantages of the technique are discussed. (auth)

6564 RADIOISOTOPE SCANNING SYSTEMS. Beck, Robert N. (Argonne Cancer Research Hospital, Chicago). ISA (Instrum. Soc. Amer.) Trans., 5: 335-48(Oct. 1966).

Radioisotope scanning is a diagnostic technique in which the in vivo distribution of a small quantity of radioactive material administered to a patient is used to detect lesions in the thyroid, brain, liver, and other body organs. Two categories of radioisotope imaging devices have been developed, namely, cameras and scanners, which have stationary and moving radiation detectors, respectively. The state of the art in scanner development is briefly sketched, some of the crucial steps in its evolution are mentioned, and possible future trends are suggested. In general, the method is so new that significant contributions may yet be made in every area, specifically: in radioisotope production and nuclear chemistry; in increasing the sensitivity and resolution of radiation detectors; and in improving the techniques of data manipulation, display, evaluation, and interpretation. (auth)

6565 TECHNIC OF DEMONSTRATION OF MELANOBLASTOMAS IN THE POSTERIOR BULBAR SEGMENT WITH ^{32}P. Juette, A. (Univ., Jena, Ger.). Klin. Monatsbl. Augenheilk., 146: 337-43(Apr. 1965). (In German).

Almost all melanoblastomas of the choroid are localized in the posterior bulbar segment of the eye. The author describes a new technique used to demonstrate these choroidal melanoblastomas by means of ^{32}P. The patient is given 700 μCi of ^{32}P orally. The greatest concentration of ^{32}P in the tumor is found 24 hr after its administration. The ^{32}P concentration in the eye is measured by insertion of a small probe into the eye after temporary removal of the lateral rectus muscle. With this procedure small tumors located at the posterior pole of the eyeball can be reliably diagnosed. Three criteria which are used to designate a positive measurement are that the difference of the average pulse rate between the tumor and surrounding tissue should amount to at least 100%, the difference between the 1-hr measurement and the 24-hr measurement should amount to at least 100%, and also the maximum value of the counting rate should be found directly over the tumor. Because of the relative insensitivity of the β radiation detector used and the short range of the β particles in tissue, the investigator must be careful to determine the exact direction from which the counting rate is increased. (BBB)

6566 USE OF NEUTRON ACTIVATION ANALYSIS IN THE EARLY DIAGNOSIS OF CYSTIC FIBROSIS IN CHILDREN. Babb, A. L.; Woodruff, G. L.; Wilson, W. E. Jr.; Heintz, P. A.; Miller, W. P.; Stamm, S. J. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 9: 591-2(Oct.–Nov. 1966).

6567 VERSATILE ISORESPONSE PLOTTING SYSTEM. King, R. J.; Brill, A. B.; King, P. H.; Kramer, C. E. (Vanderbilt Univ., Nashville). Trans. Amer. Nucl. Soc., 9: 361-3(Oct.–Nov. 1966).

6568 ANALYSIS OF THE PROTECTIVE INFLUENCE OF MEXAMINE IN THE IRRADIATION OF MICE BY 200-kV X RAYS AND ON A 4.3-MeV LINEAR ACCELERATOR. Bychkovskaya, I. B.; Bogatyrev, A. V. (Central Scientific Research Roentgeno-radiological Inst., Leningrad). Radiobiologiya, 6: 440-5(1966). (In Russian).

Mexamine, used in the irradiation of mice by x rays, exerts a distinct protective effect at radiation doses that cause death of the animals as a result of predominant injury to the bone marrow, and is of little effect in gastrointestinal forms of death. In the irradiation of mice on a linear accelerator, mexamine exerts less of a protective influence than under the action of x rays. The smaller protective effect of mexamine in experiments conducted on a linear accelerator is evidently due to the fact that under these conditions of irradiation, the percentage of gastrointestinal deaths (in which mexamine is of little effect) is higher than under the influence of x rays. Our evaluation of the influence of mexamine indicates the expediency of the use of a broad range of radiation doses and a consideration of the systemic factor in the response to irradiation in the analysis of the influence of antiradiation agents. (auth)

6569 MECHANISM OF DAMAGE TO THE HARD TISSUES OF THE TOOTH AS A RESULT OF THE INFLUENCE OF PENETRATING RADIATION. Manoilov, S. E.; Fedorov, Yu. A. (Central Research Roentgenoradiological Inst., Leningrad. Scientific Research Inst. of Stomatology, Odessa). Radiobiologiya, 6: 387-90(1966). (In Russian).

Rats were subjected to fractionated x irradiation with 60-day intervals between irradiations. Parallel with radiation studies, mineral metabolism investigations were also conducted. Determinations were made on inorganic phosphorus and calcium content in the blood serum, and incorporation of phosphorus-32 into the hard tissues of the tooth. Phosphorus-32 was administered subcutaneously two days before the end of the experiment. Absorption of phosphorus-32 by teeth of experimental rats was more than 2.5 times as great as that of control animals. The combined influence of fractionated x radiation and a carbohydrate diet was studied. Three groups of animals, A, B, and C, were kept on a carbohydrate diet from the time of birth. Group A received calcium glycerophosphate as a prophylactic; group B received sodium fluoride; group C was the control. In group A 34.4% of the teeth were injured by caries; in group B, 65.2% were injured; in group C, 75% were injured. In animals of groups A and B there was a decrease in incorporation of phosphorus-32 into the teeth. The pathogenesis of radiation injury of hard tissues of teeth is discussed. (H.L.W.)

6570 RADIOPROTECTIVE EFFECTS OF CERTAIN AMINOALKYLPHENOLS AND AMINOALCOHOLS. Tank, L. I.; Slavachevskaya, N. M. (Military Medical Academy, Leningrad). Radiobiologiya, 6: 451-4(1966). (In Russian).

The radioprotective effects of various compounds were studied using x irradiated mice. The literature data on the high radioprotective effects of methoxamine in the case of its parenteral administration were confirmed. It was found that the preparation exerts no protective effect after peroral introduction. Among the synthesized analogs of methoxamine, no compounds with radioprotective activity were detected. Metahydroxybenzylamine, in contrast to orthohydroxybenzylamine, manifests a moderate protective effect. The aminoalcohols tested have no protective effect. (auth)

6571 EXPERIMENTAL STUDIES ON THE PROBLEM OF OPTIMAL FRACTIONATION IN X-RAY THERAPY OF GENITAL CANCER. Moebius, W.; Carol, W.; Gallwas, K. (Friedrich-Schiller-Univ., Jena, Ger.). Arch. Geschwulstforsch., 23: 261-73(1964). (In German).

From 1937 to 1955 genital carcinomas were treated with daily single doses of 400 R. Since then, because of the severe skin symptoms and general effects on the patients the dose was changed to two daily single doses of 200 R. The reasons for the improved clinical results obtained by this altered irradiation procedure have been borne out by experimental studies on guinea pigs. The animals received various combinations of whole-body x irradiation in one or two doses of 100 to 400 R each. It was shown by the skin reaction and by histological study that the doubly fractionated irradiation series provided much better skin protection than an equal amount given in a single administration. Similar irradiations of the testis also showed that the single irradiation had a more injurious effect than the double irradiation. Although administration of radiation twice as frequently required greater precautions, the advantages of improved skin tolerance and a higher electivity

for the radiation effect between tumor and surrounding tissue justified doubled use of the lower single doses. (BBB)

6572 THE POTENTIATING EFFECTS OF HYPERBARIC OXYGEN AND ACTINOMYCIN D ON THE IRRADIATION OF EHRLICH ASCITES TUMOR CELLS IN VIVO. Aftonomos, Byron Th.; St. Aubin, Paul M ; Foley, John F. (Univ. of Nebraska, Omaha). Life Sci., 5: 905-13(May 1966).

This investigation was designed to demonstrate whether the potentiation of radiation by hyperbaric oxygen on solid Ehrlich ascites tumors (EAT) would be operable in the free ascitic phase of growth and whether the addition of actinomycin D to the hyperbaric oxygen would have additive potentiating effect on the system, over the latter alone. Preliminary studies were carried out to determine the effects of various radiation doses on healthy mice in air at 15 psia (Air at Normobaric Pressure, ANP) and 100% oxygen at 45 psia (Oxygen at High Pressure, OHP). At all dose levels of ^{60}Co γ irradiation tested (600, 700, 800, and 900 R) the difference in the number of animals surviving 21 days postirradiation with OHP and ANP groups was not significant. However, the difference between the means of the number of days survived by animals dying before 21 days postirradiation in the OHP and ANP groups showed a statistically significant difference at the 700- and 800-R dose levels. A 670-R dose resulting in the 50% survival of the ANP group would produce a 34% survival for the OHP group, a lethality potentiation factor of oxygen of 1.5. When the effects of hyperbaric oxygen and hyperbaric oxygen + actinomycin D on the irradiation of EAT cells in vivo was studied, the potentiating effect of these agents could be demonstrated. A decrease in the total number, size, and rate of growth of ascitic tumors in mice inoculated with treated EAT tumor cells was observed, as compared to the growth in mice inoculated with untreated cells. In general, these results support the view of the potentiating effect of hyperbaric oxygen and hyperbaric oxygen + actinomycin D on ionizing radiation and point more encouragingly to their combined use as therapeutic agents. The introduction of high pressure oxygen into radiotherapy adds to the complexity of the situation, so that the results from human and animal experimentation are not entirely consistent, and their ultimate interpretation remains to be elucidated. (BBB)

6573 VARIATIONS OF SIALIC ACID IN UTERINE NEOPLASIA BEFORE AND AFTER RADIUM THERAPY. Sanna, G.; Fortuna, A. (Ospedale Civile, Cesena, Italy). Quad. Clin. Obstet. Ginecol., 19: 901-13(Dec. 1964). (In Italian).

The fluctuations of serum levels of sialic acid and seromucoid were followed in 20 women undergoing radiotherapy for uterine cancer. The levels were determined before, during, immediately after, and one month after radiotherapy. Both sialic acid and seromucoid levels were above the normal values before radiotherapy was begun, in confirmation of previous studies showing the elevation of these substance in blood by malignant tumors. Both substances were decreased as irradiation was begun, primarily with intracavitary Ra. The values continued to fall with treatment and remained low one month after completion of irradiation. In most cases they were within the normal range. It is suggested that the elevation of these substances in uterine neoplasia reflects the depolymerization of connective tissue polysaccharides during this process. As tumor destruction is caused by irradiation the release of these substances into blood ceases. It is proposed that measurement of serum sialic acid and seromucoid levels during radiotherapy may be of prognostic value. (BBB)

6574 PREFERRED TREATMENT FOR CERVICAL CARCINOMA. Beecham, Clayton T.; Beiler, David B. (Geisinger Medical Center, Danville, Pa.). Postgrad. Med., 39: 412-15 (Apr. 1966).

Fundamental principles which should be adhered to for successful treatment and preventing complications in radiotherapy of cervical carcinoma are presented. A cancericidal dose of radiation must be delivered to the visible and palpable tumor and to the likely areas of extension. Meticulous attention must be given to the volume of tissue receiving a high dose. Large doses to large volumes produce a high incidence of complications. Treatment must be reconciled with the stage of the disease. The dose delivered to the bladder and rectum must not exceed their tolerance, which is considerably lower than that of the cervix and vagina. This point is checked carefully following insertion of the radium by using a dosimeter probe. Radium properly applied is the best means for delivering a high central tumor dose while minimizing the dose to the bladder and rectum. Attempts to treat carcinoma of the cervix with external irradiation alone, whether by combinations of external fixed fields and transvaginal cone therapy or by supervoltage rotational methods, have met with only moderate success. These results can not be compared with recent results obtained in many centers where conventional radium therapy is supplemented by adequate supervoltage irradiation. Cures in cases of stage I and stage IIa lesions are primarily dependent on radium therapy, while control of more advanced lesions depends chiefly on external irradiation supplemented centrally by radium. Cases of stage I and stage II lesions were not improved when external therapy was added to radium therapy. Stage I exophytic lesions measuring less than 2 cm are treated by two applications of radium, 55 to 85 mg for 72 hr, given two weeks apart. Other stage I and early stage IIa lesions, if not bulky, infected or badly cratered, receive identical radium therapy plus external parametrical irradiation, 3000 to 4000 rad to the midplane at the rate of 1000 rad per week, given between and following the radium applications. In advanced stage IIa, stage IIb, and all stage III lesions, the first step is the administration of 4000 rad of total pelvic irradiation, adequately covering any vaginal extension. Radium, 55 to 85 mg, is then employed for 72 hr. The total combined mucosal surface doses from external irradiation plus radium should reach 10,000 rad in the fornices and 8000 rad throughout the involved area of the vagina. Disability arising from radiation therapy is least in women who are healthy. Complications will be minimized and radiosensitivity enhanced if significant anemia and infection are corrected at the outset. Radiation therapy is tolerated best when the patient's diet is high in calories and protein and low in residue. Strict avoidance of cathartics is advised. (BBB)

6575 TREATMENT OF UTERINE CANCER WITH CONTACT AND TELERADIOTHERAPY USING RADIOACTIVE ISOTOPES. Koerbler, J.; Frank, P.; Stojanov, E. (Oncological Inst., Zagreb). Arch. Geschwulstforsch., 20: 199-209(1963). (In German).

The authors use a 1200-C telecobalt source with a diameter of 2 cm for irradiation of the uterine parametrium. This delivers ~18 R/min/m, 60 R/min at 55 cm, and 92 R/min at 44 cm. Rotational and pendulum irradiation both are possible with this equipment. Stationary lateral fields are considered preferable because the area most affected by uterine carcinoma can be irradiated best this way. By dissecting the beam with an angle of 22.5° with the vertical of the midline the pelvis and hip are not irradiated. The small intestine and bladder are irradiated little or not at all, but the inguinal lymphatic area is irradiated intensively. Irradiation with ^{60}Co produces only slight erythema or bronzing of the skin even when 4500 or 5000 R are used. The focal dose delivered to the parametrium is ~50% of the skin dose, and the skin dose at the point of exit is ~20% of the incident dose. The authors administer two fields at a single session so that 200 R reach each side of the parametrium. For tumors located on the skin surface contact irradiation, where the entire dose is administered in a single treatment regression is frequently observed within 24 hr. Combined treatment on tumors of the uterine orifice with ^{60}Co or ^{137}Cs seeds (15,000 to 30,000 rep) and fractionated doses of telecobalt irradiation of 2000 to 4000 R have been successful. For postoperative treatment of uterine carcinomas crossed irradiation at an angle of 32.5° with the midline using 1500 to 2000 R focal dose on each side has proven adequate. This results in a total focal dose at the center of the pelvis of 3000 to 4000 R. Larger doses may cause necroses. According to the authors' view, if the initial irradiation treatment does not cure the uterine carcinoma, additional treatments will have only a palliative effect. (BBB)

6576 PROBLEMS OF NEUTRON CAPTURE THERAPY. Atkins, Harold L. Atoomenergie Haar Toepass., 8: 237-42(Nov. 1966).

Neutron capture therapy remains a fascinating possibility in the treatment of human malignancy. Clinical trials using a thermal neutron beam and ^{10}B were unsuccessful in eradicating brain tumors because of poor, nonhomogeneous penetration of the neutrons. In attempting to obtain an adequate flux at the tumor depth, more superficial tissues received radiation doses beyond the tolerance level. Subsequent studies have established tolerances to thermal neutrons. An epithermal neutron beam was produced that is capable of supplying an adequate thermal neutron flux at depth should a compound of a capture nuclide be found that will concentrate sufficiently in tumors. The parameters necessary for practical neutron capture therapy are defined. (auth)

6577 TREATMENT OF CLIMACTERIC BLEEDING DISORDERS WITH MONEL-FILTERED RADIUM. Hahn, J. (Medizinische Akademie, Luebeck, Ger.). Geburtsh. Frauenheilk., 25: 749-60(Aug. 1965). (In German).

Menopausal bleeding in 254 patients was treated by the application of radium filtered with monel. Special attention was paid to whether a rod-shaped or an ovoid shaped applicator and to whether a one-stage or a two-stage procedure are preferable. A two-stage procedure with radium insertion 3 to 4 days after diagnostic curettage is advocated because of its lower complication rate (pyrexia, salpingitis). Of 210 patients seen in follow-up examinations, in 58% bleeding stopped immediately and perma-

nently following a four-hr insertion of radium, but 23% of the patients had one or several subsequent episodes of bleeding. Regular but lighter menstrual periods recurred in 8% of the patients; 10.9% of the patients required further treatment for recurrent menopausal bleeding, especially in women below the age of 45. Ovoid applicators packed into the uterus adapted more easily to the uterine cavity and gave better results than rod-shaped applicators. The radium dose varied between 200 and 560 mg-hr, with an average of 320 mg-hr. The complication rate was slightly higher with the rod-shaped applicator. Thus, among 138 patients treated with this type radium applicator, radiation malaise occurred in 7%, fever in 12%, and inflammation of the adnexae in 4%, compared with 5, 11, and 1%, respectively, with the ovoid applicator. Leukorrhea as a complication of radium treatment occurred in 34% of the cases. (BBB)

6578 TREATMENT OF ACUTE LEUKEMIA. Hayhoe, F. G. J. (Cambridge Univ.). Practitioner, 196: 87-90(Jan. 1966).

Use of total-body irradiation and transplantation of bone marrow in treatment of acute leukemia is reviewed. Recovery from high doses of radiation to the whole or a large part of the body that would otherwise be lethal can be achieved by transplanting compatible bone marrow cells, which colonize and repopulate the bone marrow and lymph glands. The success of this procedure in experimental animals and in some cases of accidental overexposure to radiation in man led to the idea that deliberate administration of high-dosage total-body irradiation followed by marrow transplantation might be tried in acute leukemia. The difficulties in this procedure are formidable. Firstly, the dose necessary to kill all leukemic cells is several times the minimal lethal dose. Moreover, the genetic heterogeneity of man makes it very difficult to obtain strictly compatible marrow cells. These difficulties, though grave, are not insurmountable. Radiation may be used to destroy most of the leukemic cells without exceeding too far the minimal lethal dose, and marrow can be transplanted which is antigenically similar though not identical to that of the recipient. Too severe an immune response could be prevented by careful choice of marrow and the simultaneous administration of such immunosuppressive drugs as azathioprine and prednisone. (BBB)

6579 FUTURE OF RADIOTHERAPY IN THE TREATMENT OF UTERINE CARCINOMA. Henschke, Ulrich K.; Hilaris, Basil S. (Sloan-Kettering Inst. for Cancer Research, New York). Arch. Gynaekol., 202: 289-304(1965). (In German).

Methods of improving radiotherapy of uterine carcinoma, including intracavitary applicator therapy, interstitial implantation, and x-ray depth therapy are discussed. The effective use of intracavitary irradiation awaits improved methods of radioprotection. One such improvement is the after loading technique, where the radiation source is introduced after its container is properly located. A method of remote loading, where the radiation sources are implanted by means of a long movable cable is detailed. An improved technique for permanent interstitial implantation of ^{222}Rn, ^{198}Au, and ^{192}Ir is also described. Although they regard x-ray depth therapy as being of secondary importance, it is still useful for palliative treatment of advanced stages and metastases. Preoperative irradiation, using ~2000 R is also useful. Studies of incidence of lymph node metastases and 5-yr survival rates indicate improvement with the technique. A nonrotating ^{60}Co irradiation unit that can be used to irradiate patients more simply and rapidly is described. (TSS)

6580 CLINICAL EXPERIENCES WITH THE USE OF CORTICOSTEROIDS DURING AND AFTER RADIATION TREATMENT OF FEMALE GENITAL CARCINOMAS. Huellemann, R. (Univ., Hamburg). Geburtsh. Frauenheilk., 25: 514-23(June 1965). (In German).

Numerous experimental animal studies have been carried out to ascertain whether glucocorticoids favor the extension and metastasis of malignant tumors. The findings have frequently been contradictory, but this may have been because of the wide variety of tumors studied. Also, the chemical structure and the dose of the corticosteroid may affect the results. Generally, corticosteroids tend to inhibit growth of lymphatic tumors, although they favor spread of other types of tumors. Results were obtained in 14 patients with uterine or ovarian carcinomas who were treated with daily doses of steroids after irradiation with a combination of 5000 to 5500 mg-hr of Ra and 4000 to 4400 R of supervoltage γ irradiation. After an interval of 1½ to 2 yr 3 were recurrence free, 6 were in poor condition, and 5 had died. There was no correlation between the time after irradiation when the corticoid treatment was started and the clinical results. The treatment was started immediately after irradiation or from 11 to 30 months later. (BBB)

6581 PRACTICAL GUIDELINES FOR TREATMENT OF CUTANEOUS HEMANGIOMAS. Gerstenberg, E.; Osterland, G.; Schondorf, K.-W. (Freie Univ., Berlin). Monatsschr. Kinderheilk., 114: 49-53(1965). (In German).

Primary complications of hemangiomas include ulceration, infection, and hemorrhage. Large hemangiomas frequently produce malformations of bones and soft tissues, such as bone shortening or oligodactyly. The Kasnbach-Merritt syndrome that frequently leads to thrombocytopenia has particular pediatric interest as a complication of hemangiomas. The size and invasiveness of the hemangioma determine the choice of irradiation to be used in treatment. For many hemangiomas ^{90}Sr dermoplates or soft x irradiation is sufficient. Close-up irradiation with a short focus-skin distance as well as fast electrons with reduced max energies are necessary for large hemangiomas with much extension in depth. Because of large uncertainties in dosage, danger to the patient and those handling it, ThX is not used in treatment anymore. Irradiation treatment is administered in single, small doses at intervals of at least 4 to 8 weeks. It should not be used if there is any danger of concurrent irradiation of radiosensitive organs or organ areas. Irradiation injuries when they do occur are due to high dosage or use of irradiation that is too energetic. Irradiation of a hemangioma in the vicinity of the breast is not advisable because of subsequent hypoplasia that may result. (BBB)

6582 CARCINOMA OF THE PROSTATE. Mellinger, George T. (Veterans Administration Hospital, Minneapolis, Minn.). Surg. Clin. N. Amer., 45: 1413-26(Dec. 1965).

Use of radioisotopes and external irradiation to treat prostatic cancer of various stages is considered. In stage III prostatic cancer the best method of radiotherapy is the injection of ^{198}Au into the prostatic tumor itself. Radiogold in a colloidal suspension is injected into the prostate through a retropubic or perineal incision. Since 95% of the radiation emitted consists of short-range β rays and since the half-life of radiogold is only 65 hr, undesirable irradiation of surrounding structures can be avoided. Radioyttrium, radon, and radium may also be employed. High-energy external irradiation has been tried with radiocobalt or supervoltage x-ray machines, but these are not advocated for general use at present. Carcinoma of the prostate is relatively radioresistant, but adequate dosage sometimes produces regression of the lesions. In treating metastases, deep x-ray therapy is directed to individual osseous lesions, or intravenous injections of radiophosphate are given. Radiophosphate may be given orally or intravenously for individual bone lesions, although intravenous injection usually is preferable. (TSS)

6583 RADIUM MANAGEMENT OF CUTANEOUS HEMANGIOMAS. Medina, Antonio; Alexander, Leslie L. (Kings County Hospital Center, Brooklyn). J. Nat. Med. Ass., 56: 6-11(Jan. 1966).

Precautions in the use of ionizing radiations to treat hemangiomas are set forth. A wide variety of types of irradiation has been used successfully in the treatment of cavernous and strawberry types of hemangioma including: surface application of β rays using radiostrontium, external application of radon or radium, and external x-ray beams. Interstitial implantation or β-ray sources, such as radiophosphorus, and of γ-ray emitters, such as radon and radium have also been used. Large lesions are treated best by radiation or surgery. Lesions overlying the epiphyses or breast, if treated, must be irradiated with extreme care, because of radioinduced inhibition of growth. Methods and advantages of treatment of cutaneous hemangiomas with radium are described. Four cases illustrate the good cosmetic results of externally applied radium. The amount of radium used varied from 36 to 160 mg with 2.0 mm of platinum filtration. (TSS)

6584 PEDIATRIC UROLOGICAL TESTS USING RADIOISOTOPES. Winter, Chester C. (Ohio State Univ. Hospitals, Columbus). J. Urol., 95: 584-7(Apr. 1966).

Fourteen urologic tests utilizing radioisotopes applicable to children are described, with emphasis on the principal advantages of isotope techniques: the reduction (compared with radiography) in radiation exposure to the patient and personnel, ease and speed with which the test may be performed, and elimination of trauma and hazard to the patient. (TSS)

6585 SURVIVAL RATE IN SUPERIOR SULCUS TUMORS TREATED BY PRESURGICAL IRRADIATION. Paulson, Donald L. (Baylor Univ., Dallas). J. Amer. Med. Ass., 196: 342(Apr. 25, 1966).

Problems involved in surgery in the irradiated field are discussed and histologic changes in tumors induced by irradiation are reported. The purpose of presurgical irradiation is to modify the neoplasm to the extent that the lesion is better localized and thus resectable with improved results, but with no increase in morbidity. The tumor dose of 3000 rad recommended for bronchogenic carcinoma in the superior sulcus is ~75% of the cancerocidal dose of 4200 rad delivered in two weeks' time, based on the Strandquist

curve, for squamous-cell carcinoma of the skin. There is no evidence that complete sterilization of local carcinoma by presurgical irradiation, if possible, insures prolonged survival. However, clinical and experimental observations indicate that presurgical irradiation in doses that are not sufficient to sterilize or cause regression of the tumors treated, decreases local recurrence, prevents the growth of tumor cells after dissemination, and increases survival, when compared with irradiation or surgery alone. Pathological examination of irradiated tissue is reported. Grossly, there is a peripheral pseudo capsule and central degeneration of the tumor. The lymphatics in the extrapleural plane adjacent to the neoplasm have fibrosed and no neoplastic cells can be found. The periphery of the tumor has been reduced to an amorphous mass. In the intermediate zone, scattered cells with pyknotic nuclei can be seen as remains of damaged cancer cells. The pathological findings indicate marked destruction, foreign-body giant-cell resection, fibrosis, degeneration, and localization of the neoplastic mass by irradiation. These pathological observations attest to the value of presurgical irradiation in the conversion of bronchogenic carcinoma to a resectable lesion. (TSS)

6586 POST-RADIATION RECURRENT CARCINOMA OF THE UTERINE CERVIX: IS RETREATMENT BENEFICIAL? Allen, William E. Jr. (Peoples Hospital, St. Louis, Mo.). J. Nat. Med. Ass., 58: 24-7(Jan. 1966).

Most radiotherapists consider that if an initial adequate course of radiotherapy is unsuccessful, further supplemental irradiation will at best be only palliative, and in fact may be contraindicated because of the possibility of serious sequelae and complications. However, the only other alternative, radical surgery, for cure carries not only a high incidence of complications and sequelae, but also a considerable mortality. In the retreatment of such cases, a calculated risk is taken and complications must be expected. Where the only alternative for cure or palliation is a mutilating operation with an appreciable mortality rate and high morbidity incidence, reirradiation seems justified. Five cases are described, in one of which the major radioinduced complication was vaginal atresia. The remaining four cases are well without evidence of either recurrence or complications. In the first case, with an epidermoid cervical carcinoma, the patient (by orthovoltage technique) was given a tumor dose of 6198 rad to the vaginal vault through four external pelvic and one transvaginal port. The mass regressed completely, but 8 yr later the patient required a colostomy for a benign stricture of the rectum. After 3 more yr biopsy revealed recurrent carcinoma. With a modified Ernst vaginal applicator, the patient was given additional intravaginal γ irradiation to the vaginal vault of 14,700 rad. Untoward sequelae were expected following this intensive re-treatment, and although there was complete regression of the recurrent lesion, atresia of the vagina did occur. (BBB)

6587 RADIOTHERAPY FOR MALIGNANT MELANOMA OF THE CHOROID. Stallard, H. B. (London Univ.). Brit. J. Ophthalmol., 50: 147-55(Mar. 1966).

Clinical results, complications, and dose data are reported for 100 cases of malignant melanoma of the choroid treated with radioisotopes. The concept that malignant melanomas are radioresistant is questioned. The effective application of radiotherapeutic technique to date has been by means of either radium or ^{60}Co-loaded applicators, sutured to the sclera, exactly overlapping the base of the neoplasm by at least 1 mm. In the two patients in whom it was tried, ^{60}Co beam therapy failed, but success followed the use of radioactive applicators. Calculations from isodose curves suggest that most (63 out of 100) received between 7000 and 14,000 R at the summit and between 20,000 and 40,000 at the base in 7 to 14 days, respectively. Of the 69 successes, 55 had a single radioactive application and 14 had two treatments. A total of 69 patients out of 100 have shown postirradiation recession of the neoplasm to a flat, pigmented scar and attenuation of the retinal vessels in the vicinity. (TSS)

6588 CARCINOMA OF THE CERVIX IN PREGNANCY AND THE PUERPERIUM. Tenner, Michael S. (Univ. Hospital, Baltimore). Maryland State Med. J., 14: 63-5(Oct. 1965).

Problems encountered in the use of radiotherapy in pregnant patients are discussed after a consideration of possible effects of pelvic irradiation on the fetus. A whole-body dose of 400 rad is almost always lethal to the fetus and usually produces abortion within six weeks. Sublethal doses may produce many malformations, the type of abnormality being related to the time of gestation at which the irradiation was given and to the protraction of the irradiation. The tolerance of irradiation increases with fetal age, and at full term the tolerance is similar to that of an adult. There are cases of localized irradiation to the fetal head from vaginal radium in which the only abnormality produced was epilation of the fetal scalp. The basic principles of treatment policy are summarized. The state of pregnancy will not alter the behavior of cervical carcinoma either from the standpoint of its local or distant spread or its responsiveness to irradiation. Any trauma (surgical interference or pelvic delivery) should be avoided if at all possible before irradiation. The longest period possible between the beginning of irradiation and delivery should be obtained. In general, this means using vaginal radium first. This is followed by external irradiation using high total pelvis doses and ending with intrauterine radium a few days after the uterus is emptied. Hence, the activity of the tumor cells is reduced before the trauma of delivery occurs. External irradiation should always be given in sufficient amounts to produce the death of the fetus. If the dose has not proved lethal, the consequent malformations may ultimately prove to be so. Results of treatment of 26 cases are reported. (TSS)

6589 RADIATION HAZARDS TO MOTHER AND FETUS. Cooper, George Jr., Cooper, Joseph Byron (Univ. of Tennessee, Memphis). Clin. Obstet. Gynecol., 9: 11-21(Mar. 1966).

In man, evidence indicates that the period from the second to sixth week of gestation is probably the most susceptible to radiation damage; and this is the period when pregnancy may be unsuspected. Exposure at later stages in gestation may cause less obvious changes. Doses as low as 25 rad have produced malformations in experimental animals if given at critical periods. The threshold levels for somatic and genetic effects to the fetus and the maternal gonads have not been established, but the effects appear to be proportional to the radiation dose. In childhood, cancer and leukemia may develop after very low levels of irradiation, perhaps as low as 1 R. Thus, intrauterine radiation even for medical diagnostic purposes involves a hazard. The exact nature of the mechanism by which the embryo is damaged is unknown, but it has been shown that the effects are brought about by direct action on the newly developing organism rather than by indirect action on the mother. For this reason, there should be no risk to the fetus during nonpelvic or abdominal examination of the mother if the gravid uterus is shielded. Many radiologists recommend that diagnostic exposure of females of reproductive age be limited to the first 10 days after the last normal menstrual period unless there is a medical emergency. Practical problems arise, and unfortunately the determination of the urgency of an x-ray examination may not be possible until after a diagnosis has been established. It is further recommended that nonessential exposure be avoided during pregnancy, and that nonpelvic examination of the pregnant female include shielding of the fetus. (BBB)

6590 IRRADIATION OF CERVICAL CARCINOMAS WITH SPECIAL CONSIDERATION TO THE PROBLEM OF RADIATION INJURY. Fuchs, G.; Hofbauer, J. (Kaiser-Franz-Josef-Spitals, Vienna). Krebsarzt, 19: 412-22(1964). (In German).

The results of postsurgical x-ray treatment of cervical cancer of the uterus are reported for 116 patients. The patients were each irradiated with 5 series of fractionated doses, administered over a period of three yr. The first series was started very soon after surgery, and did not interfere with wound healing. Each point in the pelvic area received from 1200 to 1400 R during the first series, and at least 1000 R during the following series. The total dose administered to each region is at least 5000 R. The hypogastric lymphatics were included within the irradiation fields. The youngest patient was free of tumor recurrence for 15 yr. The two oldest patients were recurrence-free for 7 and 11 yr. The average age of the patients was 46.9 yr. Of the total of 116 patients, 62 were free of recurrences for longer than 5 yr, 40 have died, and the results are unknown for 14. The cure rate amounts to 54 ± 4.6%. Skin damage caused by the irradiations were not related to the dose administered. In 5 patients spontaneous fractures of the femur neck were observed. No urological complications were observed, and the parametral connective tissue did not become sclerosed even when doses as high as 6000 to 8000 R were given. (BBB)

6591 CONCERNING OF A SEVERE CASE OF RADIONECROSIS OF THE LOWER JAW AND THE CHIN. POSSIBILITIES OF REPAIR OFFERED BY PLASTIC SURGERY. Goumain, A. J. M.; Fevrier, J. C. (Hopital Saint-Andre, Bordeaux). J. Med. Bordeaux Sud-Quest, 142: 1397-1404(Aug. 1965). (In French).

Surgical-procedures are described in detail and illustrated for the case of a 59-yr-old man with radionecrosis of the lower jaw and of the chin, who was treated by excision and reconstruction at two levels: an intrabuccal level where a median cervical flap was folded back for grafting; and a surface level, using a frontal flap with a bitemporal pedicle. The frontal flap with bitemporal pedicle is convenient because it can be performed relatively quickly and is a reliable operation. It is best to perform a tracheotomy before any attempt of reconstruction of the lower jaw. Means are also described whereby a bone graft can be inserted beneath the frontal flap to reconstruct the mandibular arc. (TSS)

6592 EFFECT OF PHYTOHAEMAGGLUTININ ON MARROW REGENERATION IN RODENTS. Papac, Rose J. (Yale Univ., New Haven). Lancet, 1: 63-5(Jan. 8, 1966).

Phytohemagglutinin (PHA), an extract of Phaseolus vulgaris, stimulates mitosis and morphological changes in small lymphocytes. Studies were undertaken to ascertain whether PHA could stimulate bone marrow regeneration after irradiation. Mice were x-irradiated with one of three doses: 900 R, 700 R, or 600 R. Rats were irradiated with 850 R. PHA was administered intravenously 1 to 2 hr after irradiation. The results indicate that PHA did not stimulate marrow regeneration in mice or rats exposed to varying amounts of irradiation. The doses studied included the highest tolerable amounts of PHA, so the likelihood of obtaining myelostimulatory effect at less toxic levels would be negligible. There was a lack of protective effect against irradiation, as determined by survival experiments, in animals given PHA. Toxic effects were observed after injections of PHA in mice. On the basis of morphological findings and marrow counts, the ability of PHA to stimulate lymphocytes in vitro was not indicative of in vivo transformation or stimulation. (TSS)

6593 THE PHYSICAL BASIS OF THE USE OF ^{86}Rb TO MEASURE RENAL BLOOD FLOW BY EXTERNAL SCINTILLATION COUNTING. Sear, R.; Blandy, J. P.; Ritchie, H. D. (London Hospital). Brit. J. Urol., 37: 493-8(Oct. 1965).

Various physical parameters that would affect the sensitivity and selectivity of renal scanning with ^{86}Rb were examined with the aid of phantom measurements. Experiments in dogs had shown that, about one min after an intravenous injection of ^{86}Rb, the activity/g of kidney was more than ten times the activity/g of other tissues such as liver, spleen, muscle, and blood. This peak concentration in the kidney was built up sufficiently rapidly after the injection for it to be regarded as directly proportional to blood flow into the kidney. If it were possible to compare the total activities in the two kidneys of a patient by means of a pair of matched scintillation counting systems mounted outside the patient, this should provide a comparison of the rates of blood flow to the two kidneys. However, several physical problems required consideration if this in vivo technique were to yield results capable of systematic interpretation. To simulate a kidney, 340 ml of water containing 10 μC ^{86}Rb was introduced into a rubber bag, which was then formed with metal clips into a reniform shape. To simulate the trunk of a patient, a cubical Perspex tank was used, partly filled with water. Measurements on a phantom with a scintillation counter, using a 1¾ by 2 in. crystal, indicated that the count rate expected externally to the body over a normal human kidney after an intravenous injection of ^{86}Rb would be about two and a half times that obtained when the counter is moved off the kidney. To achieve this result, the collimation must be such that when the counter is correctly positioned over the center of the kidney the latter almost entirely fills the field of view, and the shielding must nowhere be less than the equivalent of 1½ cm of lead plus 2½ cm of steel. (BBB)

6594 MITOTIC ACTIVITY AND RADIATION RESPONSE IN UTERINE MALIGNANCY. Cox, L. W.; Wakonig-Vaartaja, R.; Harvey, N. D. (Univ. of Adelaide). Austral. N. Zeal. J. Obstet. Gynecol., 5: 131-7(Aug. 1965).

Effects of radiation on chromosomes of tumor cells were examined in attempts to develop a prognostic technique. Squash preparations were made and the chromosomes of individual cells counted and morphological abnormalities recorded by phase contrast microscopy. Serial biopsies were also studied while irradiation was being administered. Intracavitary radiotherapy was given by 3 uterovaginal ^{60}Co insertions at 14-day intervals, using Sheffield pattern vaginal applicators and a uterine tube. The radiation dose at Point A was 5000 to 6000 rad and at Point B 1500 to 2000 rad. In most cases, supplementary supervoltage radiotherapy to the lateral pelvic areas was commenced between the second and third insertions. The total radiation dosage in a full course of treatment was Point A 6000 to 6500 rad and Point B 3500 to 5000 rad in a period of 5–6 weeks. The radiation dose at the tumor site from which the biopsies were taken was about 5000 to 6000 rad for each insertion of ^{60}Co. Accurately determinable biopsies were taken 14 days after the first treatment and 14 days after the second treatment. In most patients, after the first ^{60}Co application, active cell divisions were not visible. Biopsies usually showed cell structure, but the nuclei of the cells were damaged and no mitoses were seen. In 7 out of 18 patients, active cell divisions persisted after the first application of ^{60}Co. Exact chromosomal counts and karyotype analyses were not possible, because of severe radiation damage to the chromosomes (surface stickiness fragmentation and nucleic acid depletion). In two patients, divisions were still present after the second application and, in one patient, after the third. Histological preparations in most cases showed cells with nuclear damage. In the last-mentioned case, although mitotic activity was still present, histological examination did not suggest viability of the cell. In 5 patients where active cell divisions had persisted, the normal treatment with intracavitary cobalt was completed and, at a later date, radical hysterectomy was performed. All patients in whom mitotic activity had ceased after the first ^{60}Co application remained free from disease (except one where early metastases occurred outside the field of irradiation). The longest period of follow-up is 2½ years. (BBB)

6595 TREATMENT OF RETINOBLASTOMA. Stallard, H. B. Ophthalmologica, 151: 214-30(1966).

Use of ^{60}Co applicators in the treatment of 118 children with retinoblastoma is described, with an account of effects of radiation on the tumor, doses used, clinical results, and complications of irradiation. Retinoblastoma is 4th in the order of radiosensitivity of neoplasms, but after repeated treatment its radiosensitivity becomes decreased. Radiotherapy, with ^{60}Co applicators, for retinoblastoma less than 10 mm in dia is so effective that there is no case for excising a unilaterally affected eye containing a neoplasm of this size or less. From serial sections through irradiated retinoblastomas it was found that 3500 R was lethal to the tumor cells, so radioactive applicators for attachment to the sclera over the base of the neoplasm were designed to deliver a dose of 4000 R to the summit of the neoplasm in 7 days. Of 69 children with ¼ or less of the retina affected treated by ^{60}Co applicators, in 63 the neoplasm was destroyed and useful vision conserved. One child after initial successful destruction of the tumor had a severe vitreous hemorrhage from irradiation damage to large branch of the central retinal vessels and developed complicated glaucoma. When more than ½ the retina has been involved in the neoplasm, despite destruction of the retinoblastoma, vision will inevitably be poor and the incidence of serious intra-ocular complications will be high. Seven children have become blind from vitreous hemorrhage, 3 have had their eye excised on account of complicated glaucoma, and in 7 the result is still uncertain pending the absorption of the vitreous hemorrhage. In 5 children who had received initial treatment with deep x rays (in all it had failed), followed with successful ^{60}Co application, 4 had irradiation cataract, the incidence of which is higher after this form of radiotherapy than the others. Moreover deep x-ray doses of over 3500 R have induced malignant neoplasms in skin, temporal muscle, orbit, and nose and have caused development defects in the temporal fossa and nasal bridge. (BBB)

6596 HISTOLOGICAL AND HISTOCHEMICAL STUDY OF BLADDERS REMOVED FOR CANCER AND PREVIOUSLY TREATED WITH COBALT THERAPY AND ROENTGEN THERAPY. Coppola, R.; del Vaglio, B.; Montanaro, R.; Striano, V. (Ospedale Civile, Caserta, Italy). Gazz. Sanit., 36: 35-8(1965). (In Italian).

The effects of radiation on the bladder were studied by making histological and histochemical comparisons of 4 nonirradiated bladders with 4 removed after x-ray therapy and 2 removed after ^{60}Co treatment for bladder cancer. In the nonirradiated, tumor-bearing bladder, inflammatory changes were present in the stroma surrounding the tumor. In the x-irradiated bladder the stroma showed edema, hyalination of connective tissue, and irregular deposition of periodic acid-Schiff-positive material which was not metachromatic. Blood vessels were markedly altered, especially their intimal layer. Metachromatic material was found in the muscular and adventitial layers of the vessels, indicating accumulation of mucopolysaccharides. Elastic fibers and membranes showed fragmentation and, in some areas, lysis. Similar changes were noted in the ^{60}Co-irradiated bladders. In both cases the effectiveness of irradiation on the tumor cells was evident. Regressive changes in these cells are described. (BBB)

6597 IRRADIATION OF THE EAR. Leach, Wilfred. J. Laryngol. Otol., 79: 870-80(Oct. 1965).

Injurious effects on hearing were investigated in 56 patients irradiated for tumors in the ear region. Many of these patients complained of hearing loss during or after radiation treatment of lesions near the ear. The dose received at the inner ear and duration of administration were examined as well as an audiometric record of the hearing before, during, and after treatment. Vestibular function was investigated when possible and other effects were noted on otoscopic examination. Of the 56 patients investigated, the labyrinths of 20, or 36%, were affected at some time or other as a result of irradiation. The eventual amount of hearing loss bore no direct relation to the total dose received by the inner ear. This varied from as little as 3000 rad up to 12,000 rad for those affected and from 2500 rad up to 7000 rad for those whose ears were not affected. (TSS)

6598 DELAYED TRANSITORY CLINICAL MANIFESTATIONS AFTER RADIATION TREATMENT OF INTRACRANIAL TUMORS. Boldrey, Edwin; Sheline, Glenn (Univ. of California,

San Francisco). Acta Radiol. Therapy, Phys., Biol., 5: 5-10 (1966).

Attention is called to the appearance of adverse signs and symptoms during the first ten weeks following completion of x or γ radiation therapy to intracranial lesions, the therapy being in the general range of 5,000 rad estimated tumor dose. The peak incidence is during the second month. The duration of these symptoms may vary for from a few days to as long as six weeks. The degree of adverse response may be minor or may reach the stage where hospitalization for supportive therapy is imperative. Recognition of this possible development is important to avoid usually valueless exploration of the cranial wound. The manifestation is apparently unrelated to the type or origin of ionizing radiation or to the basic neoplastic process as long as brain tissue is implicated in either the process or the surgical therapy thereof. The manifestation is unrelated to the ultimate therapeutic result. (auth)

6599 RADIATION THERAPY OF INTRACRANIAL TUMORS: LONG TERM RESULTS. Bouchard, Jean (Royal Victoria Hospital, Montreal. McGill Univ., Montreal). Acta Radiol. Therapy, Phys., Biol., 5: 11-16(1966).

Indications for the radiotherapy of neoplasms of the central nervous system are discussed. Results are summarized from the radiation therapy of over one thousand patients with intracranial tumors. Over 15% of the patients were children under 15 years of age at the time of irradiation of their skulls and intracranial contents for primary brain tumors. The majority of patients with primary brain tumors were treated by surgery followed by intensive x or γ irradiation initiated 2 to 3 weeks after operation. About 12% of the patients were treated with irradiation only. The results of the treatment are evaluated as to length of survival and quality of survival. The data indicate that very good long term results are obtained from the use of ionizing radiation therapy in the management of malignant intracranial neoplasms. (C.H.)

6600 GAMMAMED, A TRANSPORTABLE UNIT FOR INTERSTITIAL THERAPY USING RADIOISOTOPES. Mundinger, F.; Sauerwein, K. (Univ., Freiburg i. B. Isotopenlaboratorium, Duesseldorf). Acta Radiol. Therapy, Phys., Biol., 5: 48-52 (1966). (In German).

The construction and mode of operation of the GammaMed, a new transportable unit for interstitial radiotherapy of brain and pituitary tumors, are described. A cannula is placed in the tumor and through it an ^{192}Ir source of radiation of about 100 Ci is introduced. The GammaMed is also suitable for the irradiation of body cavities and tumors. (auth)

6601 EFFECT OF NEUTRON CAPTURE IRRADIATION UPON MALIGNANT BRAIN TUMORS IN MICE. Entzian, W.; Soloway, A. H.; Raju, R.; Sweet, W. H.; Brownell, G. L. (Massachusetts General Hospital, Boston). Acta Radiol. Therapy, Phys., Biol., 5: 95-100(1966).

In situ-produced alpha particles resulting from boron-neutron capture irradiation had a markedly deleterious effect upon a murine ependymoblastoma. There appears to be a correlation between length of irradiation and inhibition of tumor growth. (auth)

6602 BIOCHEMICAL STUDY OF TUMOR ACCUMULATION OF RADIOISOTOPES USED IN BRAIN TUMOR DIAGNOSIS. Gerhard, H.; Mundinger, F. (Neurochirurgische Klinik, Freiburg i. B.). Acta Radiol. Therapy, Phys., Biol., 5: 118-22(1966). (In German).

Experiments with malignant cells found in ascites and with isolated cells from a glioma offered an explanation of the storage and retention patterns of radioisotopes used for diagnosis by means of scintillation scanning. The high storage rates of ^{206}Bi and ^{64}Cu result through deposits in the intracellular and extracellular portion of the tumor; ^{203}Hg-neohydrin is also stored intracellularly, but to a lesser degree; ^{131}Iodine-albumin mainly occupies the extracellular space, but is capable of penetrating into the cell itself; and ^{74}As is an extracellular ion, at least where malignant cells are concerned. (auth)

6603 EFFECTS OF HIGH ENERGY PROTONS ON BRAIN AND GLIOMA OF MICE. Nystroem, Stig H. M. (Massachusetts General Hospital, Boston. Harvard Univ., Boston). Acta Radiol. Therapy, Phys., Biol., 5: 133-48(1966).

Subcutaneously grown ependymoblastomas in C3H mice and mouse brains were subjected to proton doses ranging from 1,000 to 20,000 rad. A beam emerging from the Harvard 160 MeV synchrocyclotron was used and the reduction in successful tumor transplantation as a function of the dose of protons delivered to the tumors prior to the transplantation was determined. Specimens of irradiated tissues and controls were taken for histopathological and ultrastructure studies and the possible significance of the results is discussed. (auth)

6604 OSTRAYA RADIATSIONNAYA TRAVMA U CHELOVEKA. (Acute Radiation Injury in Man). Kurshakov, N. A. Moscow, Izdatel'stvo Meditsina, 1965. 315p.

The fundamental aspects of pathogenesis, diagnosis, and treatment of acute radiation sickness in man, induced by external gamma irradiation in doses considered lethal, are discussed in detail along with a thorough account of the medical treatment for radiation sickness. (G.O.Y.)

6605 RADIOISOTOPOVE DIAGNOSTICKE METODY. (Radioisotope Diagnostic Methods). Brousila, J.; Dienstbiera, Z. (eds.). Prague, Statni Zdravotnicke Nakladatelstvi, 1965. 269p.

Following an introductory section on the physical properties of radioisotopes and the basic physical properties on which their diagnostic uses are based, the literature (more than 300 references from various countries, mostly 1962 or earlier) on such uses is reviewed. The uses mentioned include tests of thyroid function, diagnosis of diseases of the blood and blood-forming organs, determination of circulatory conditions, diagnosis of gastrointestinal tract diseases, study of body fluids, determination of kidney function, and detection of brain obstructions and lesions. The isotopes mentioned include ^{47}Ca, ^{133}Xe, ^{85}Kr, ^{123}I, and ^{132}I as well as those in more common use, e.g., ^{131}I, ^{32}P, ^{24}Na, and ^{198}Au. (TTT)

6606 DUPLICATION OF PHOTOSCANS BY RAPID PHOTOCOPY TECHNIQUES. Myers, David J.; Dodge, Timothy (Veterans Administration Hospital, Long Beach, Calif.). 11p. (CONF-660642-2). ORAU. Gmelin, AED-CONF-66-237-3.

From Society of Nuclear Medicine, 13th Annual Meeting, Philadelphia.

Copying techniques that may be used for producing facsimiles of photoscans in which the size, format, and original contrast of the scintiscan can be varied practically at will are discussed. Such techniques are especially useful in rapidly and conveniently relaying a pictorial record of scintiscans to interested personnel when individual clinical interpretation of the original photoscan is impractical. Additional benefits from most of the copying techniques evaluated in this study may be gained by use of their ability to compensate for certain inadequacies in the contrast characteristics of the original photoscan. (auth)

Radiation Effects on Animals

Refer also to abstracts 6401, 6429, 6447, 6473–6475, 6480, 6519, 6592, and 6594–6597.

6607 (AD-632819) STUDY ON LOCALIZED RADIOLESIONS IN THE CENTRAL NERVOUS SYSTEM. Annual Summary Report No. 2, February 1, 1961–January 31, 1962. Karlson, B.; Larsson, B. (Uppsala Univ. (Sweden)). Feb. 27, 1962. Contract AF 61(052)-183. 3p. CFSTI $1.00 cy, $0.50 mn.

Progress is reported on: observations on pigeons with prethalamic radiolesions in the nervous pathways from the telencephalon; changes in peripheral nerve tissue after irradiation with high energy protons; early morphologic changes in spinal ganglia irradiated by 185 MeV protons; and a system for automatic densitometry for the measurement and calculation of radiation dose distributions. (H.G.D.)

6608 (AD-640500) EFFECTS OF CONTINUOUS IRRADIATION OF MICE ON THE IMMUNE RESPONSE TO LIVE LISTERIA MONOCYTOGENES VACCINE. Stewart, R. H.; Hodge, F. A.; Silvermann, M. S. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 19, 1966. 20p. (USNRDL-TR-1072). CFSTI $1.00 cy, $0.50 mn.

Mice exposed continuously to radiation delivered at 1.0 to 1.5 rad/hour were exposed to a respiratory infection with a midlethal dose of a live avirulent strain of Listeria monocytogenes immediately after accumulating either 1700 to 2200 rad or 2800 to 3000 rads. The surviving mice were challenged two weeks later with a second aerosol containing the organism in order to determine their immune state. All of the nonirradiated mice exposed to the two aerosol infections survived while 24% of the 1700 to 2200 rad irradiated mice and 54% of the 2800 to 3000 rad groups succumbed to the second infection. If the irradiated mice were immunized with two aerosol exposures at a two week interval both the irradiated (2200 rad) and the nonirradiated animals survived. Immunity following a single exposure was of short duration. If the challenge was postponed until 4 weeks after the immunizing exposure, 90% of the irradiated mice died. Clearance of L. monocytogenes from the lungs, liver and spleen was rapid in the nonirradiated immune group. By the fourth day after challenge, few organisms could be isolated. If the mice were irradiated prior to immunization, clearance was delayed. Bacteria could still be found in all organs. Large numbers of bacteria could be isolated from both groups of non-immune mice. (auth)

6609 (BNL-10445) RECOVERY OF MAMMALS FROM LATE RADIATION EFFECTS. Curtis, Howard J. (Brookhaven National Lab., Upton, N. Y.). [1966]. Contract AT(30-2)-Gen-16. 20p. (CONF-660635-3). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Colloquium on Radiations and Aging, Semmering, Austria.

Correlations relating nuclear damage to natural aging and radioinduced life shortening are reviewed, and relevance to recovery mechanisms is discussed. Cellular recovery processes are further related to the observed death rates in animal and human populations. It is concluded that recovery may be either by cell selection at the time of cell division, by chromosomal repair in interphase cells, or by both. Radiation mortality data in mice and men showed that recovery from radioinduced leukemia does occur. Efficiency of recovery processes appeared to be greater in man than in mice. (H.G.D.)

6610 (BNL-10657) LYMPHOID CELL LINES IN THE THORACIC DUCT OF THE CALF WITH DIFFERENT GENERATION TIMES. Safier, S.; Wagner, H. P.; Cottier, H.; Rai, K.; Jansen, C. R.; Cronkite, E. P. (Brookhaven National Lab., Upton, N. Y.). [1966]. Contract AT(30-2)-Gen-16. 9p. (CONF-660643-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Conference on Germinal Centers of Lymphatic Tissue, Bern, Switzerland.

Evidence is presented indicating that at least two populations of lymphoid cells with different tinctorial properties and unequal DNA synthesis and generation times exist in the thoracic duct of calves. A single intravenous injection of ^{3}H-thymidine was given after extracorporeal irradiation of circulating blood. The population having more-basophilic cells had a DNA-synthesis time of $3\frac{1}{2}$ hrs and a generation time of $5\frac{1}{2}$ to 6 hrs, whereas the population(s) having less-basophilic cells were characterized by longer DNA-synthesis and generation times. (H.G.D.)

6611 (NYO-2018-8) FURTHER INVESTIGATIONS CONCERNING THE EFFECTS OF COSMIC RAY HEAVY NUCLEI AND OF MICROBEAMS ON MAMMALIAN SKIN. Final Summary Report, May 1, 1957-March 31, 1966. Chase, Herman B. (Brown Univ., Providence, R. I.). Sept. 19, 1966. Contract AT(30-1)-2018. 5p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work performed during the contract period is summarized. In general the work confirmed the original hypothesis that cosmic ray heavies may have more of a tissue effect than a cellular effect, as predicted on physical grounds, and that there are radiation effects that depend more upon arrangements of cells than upon individual cellular viability. A list of 19 publications resulting from work done under the contract is included. (H.G.D.)

6612 (ORNL-P-2413) LONGEVITY AS INFLUENCED BY IRRADIATION IN GERMFREE MICE. Walburg, H. E. Jr.; Cosgrove, G. E.; Upton, A. C. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 10p. (CONF-660635-5). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Colloquium on Radiations and Aging, Semmering, Austria.

Incidence of disease and life span were examined in conventional and germfree mice to determine the effects of the microbial environment on radioinduced aging. Data indicate that although the absence of detectable microbial flora and fauna may alter the form of the survival curve, and may increase the mean age of death, it does not increase the maximum age of death. It is also evident that senescent changes and the life-shortening induced by x-irradiation occur in germfree mice as well as in conventional mice, suggesting that the microbial environment is not crucial to the development of such phenomena. (H.G.D.)

6613 (ORO-3489-1) THE EFFECTS OF RADIATION AND IMMUNOSUPPRESSIVE DRUGS ON ANTIBODY FORMATION AND ALLERGY. Progress Report, December 1, 1965-August 10, 1966. Jennings, B. R. (Tennessee Univ., Memphis). Aug. 10, 1966. Contract AT(40-1)-3489. 4p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Experiments were performed to explore the temporal relation between the administration of x radiation (100 R) and actinomycin D (4μg) and the antigenic stimulus (aluminum phosphate adsorbed tetanus toxoid) in mice. The doses of actinomycin D and radiation were both well below the levels generally used for immunosuppression, so that the potentiating effect was more evident. The two agents suppressed antitoxin production to a greater degree than either of the agents alone when given one or two days prior to the secondary antigenic stimulus. Potentiation was not evident, however, when the agents were given at the time of antigenic stimulus or several days afterward. Immunosuppression by either agent alone required significantly higher doses of the individual agent than when the two were administered together. (H.G.D.)

6614 (SZS-10(1966)) DIE NATUERLICHE STRAHLENBELASTUNG DES MENSCHEN DURCH AEUSSERE QUELLEN. (The Natural Radiation Burden to Man from External Sources). Ohlsen, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Sept. 1966. 45p. (In German). Dep. mn.

Environmental sources of penetrating radiation and effects of such sources on man are discussed. Methods for measuring the γ dose, γ dose-rate, neutrons, and dose to population from natural background radiation are considered. Applications of radiogeological measurements to dosimetry are presented. Two hundred twenty nine references are included. (H.G.D.)

6615 (TID-23371) IMMUNOCYTOLOGICAL STUDIES OF X-IRRADIATED MOUSE EMBRYOS. Progress Report. (California Univ., San Francisco. Medical Center). [1966]. Contract AT(11-1)-34. 15p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Progress is reported on studies of: postnatal development of the mouse oviduct; comparative radiosensitivity of tubal oocytes, ootids, cleavage stage embryos, and unimplanted uterine blastocytes; nuclear and cytoplasmic damage in oviducal mouse embryos following in vitro x-irradiation of the unfertilized egg; the culture of pre-implantation mouse embryos; serum antigen transfer in the mouse ovary; follicle stage differences in the transfer of ^{131}I-human serum albumin from the blood into the mouse ovarian oocyte; and differential nuclear and cytoplasmic localization of native serum components in mouse ovarian oocytes. (H.G.D.)

6616 INFLUENCE OF ULTRAVIOLET RAYS ON THE VARIOUS PROPERTIES OF BLOOD IN CHICKENS SICK WITH SALMONELLA PULLORUM DISEASE. Adzhemyan, Kh. G. Biol. Zh. Arm., 19: No. 6. 67-72(June 1966). (In Armenian).

The effects of ultraviolet light on some properties of blood and albumin states of pullorum chickens were studied. In the blood of chicken-bacillus carriers, in comparison with the controls, the quantity of erythrocytes, leucocytes, and thrombocytes and the concentration of hemoglobin increased. The composition of leukocytes was characterized by the increase in quantities of eosinophils, young psuedoeosinophils, and lymphocytes with simultaneous reduction of the quantity of segmented nuclear pseudoeosinophils. In chicken-bacillus carriers the alkali reserves, the blood erythrocytes, and quantity of the total albumin increase because of the increase of the albumin and gamma globulin fractions. Ultraviolet light increases the resistance of the chicken bacteria carrier to infections by Salmonella pullorum. (tr-auth)

6617 LABORATORY STUDIES TO STERILIZE THE BOLL WEEVIL WITH RADIATION. Mayer, M. S. (Dept. of Agriculture, Gainesville, Fla.); Brazzel, J. R. Ann. Entomol. Soc. Amer., 59: 284-90(Mar. 1966).

Preliminary to attempts to develop a sterile-male technic to eradicate the boll weevil, the radiosensitivity of eggs, pupae, and adults was studied by exposure to ^{60}Co γ radiation at a dose rate of 700 R/min. Doses of 7200 R or less delivered to 12- or 36-hr-old eggs of Anthonomus grandis failed to sterilize, but did decrease the longevity of ensuing adults. Doses of 800 to 24,250 R applied to 12- to 36-hr-old pupae failed to sterilize the adults at any dose low enough to permit adult survival for at least 10 days with sufficient vitality to copulate. A dose of 8000 R delivered to 12- to 36-hr-old adults reduced sperm fertility to about 18%; these adults lived for as long as 20 days and mated apparently normally for at least 10 days postirradiation. Multiple mating experiments indicated that the last mating of the female was the effective one, but only if it was with a normal male; otherwise, there was a competitive effect between the irradiated and nonirradiated sperm. Thus sterile males which inseminated females with prior fertile matings could reduce egg viability to 50% of its normal level, indicating that sterile males could be used in the field with some degree of effectiveness. (BBB)

6618 X-RADIATION AND TEMPERATURE MODIFICATION OF REPRODUCTIVE PERFORMANCE OF SINGLE-SPECIES AND MIXED-SPECIES CULTURES OF TRIBOLIUM CONFUSUM AND T. CASTANEUM. Erdman, Howard E. (Battelle-Northwest, Richland, Wash.). Physiol. Zool., 39: 160-70(Apr. 1966).

Experiments were performed to determine the influence of different x radiation doses on the productivity of genetically similar (wild-type) insect populations and to determine modifications due to temperature and coexistence. Dominant lethals in single-species populations and total lethality in mixed-species populations were determined. Adult flour beetles, T. confusum and T. castaneum, sexed as pupae and maintained separately for 3 weeks after adult emergence, were given 0, 1575, or 2625 R doses of x rays. Single- and mixed-species populations were established and incubated at 25, 29, or 32°C at 65%-70% relative humidity. Productivity was determined during 10 weeks postirradiation. Reproductive abilities increased with increased temperature and

decreased with increased x-ray exposure for a given temperature. The reproductive fitness of T. castaneum was superior in all environments except at 0 R, 32°C. The frequencies of dominant lethals (which included lethality due to coexistence in mixed-species populations) increased with higher x-ray doses, but temperature and cohabitation influenced their expression within a species. Coexistence was responsible for a considerable reduction of productivity, which was also altered by temperature and x-ray exposure. The rigors of coexistence were lessened at 2625 R, due to reduced population density. Interpretations of dose-response curves on the bases of single-hit and multi-hit radiation phenomena were inferred from similar responses of diverse organisms. Most lethality occurred in the early (eggs to young larvae) part of the life cycle for both species. Species proportions in coexistent populations varied with temperature and x-ray dose but T. castaneum was consistently less sensitive than T. confusum. The greater variability of T. castaneum probably makes it more fit in environments featuring different temperatures and x-radiation exposures plus coexistence. Responses to radiation of single-species populations cannot be used to predict those of mixed-species populations. (BBB)

6619 SOME ASPECTS OF THE RELATIONSHIP OF RADIOACTIVITY TO LUNG CANCER. Marsden, Ernest. New Zeal. Med. J., 64: 367-76(July 1965).

Evidence for association of environmental α radiation and incidence of lung cancer is reviewed. There are some indications that polonium may be a factor in lung cancer initiation or development. Experimental evidence reveals that polonium-210 is present in appreciable quantity, i.e., of the order of 0.6 pC/g in cigarette tobaccos. For an individual smoking two packages of cigarettes a day the radiation dose to bronchial epithelium from polonium inhaled in cigarette smoke is at least seven times that from background sources. Epidemiological or statistical evidence is reviewed. The tobaccos grown on the soils of old granite or granodiorite origin in Rhodesia are particularly radioactive, followed by the tobaccos from somewhat related soils in North Queensland. The New Zealand Motueka tobacco soils are of very low intrinsic activity and the tobaccos grown on them also carry little radioactivity of any sort. Increase in death rates of specific age groups in the United Kingdom since 1910 shows a remarkable correspondence with the figures of increasing importation of Rhodesian tobacco. The rate of increase of lung cancer mortality per 100,000 in New Zealand is much more pronounced than the increase of cigarette smoking per capita. A feasible explanation is that over the previous 20 years the amount of cigarette tobacco leaf grown and used in New Zealand has shown great increase and has replaced much tobacco from the U.S.A. thus reducing the average radioactivity of local cigarettes. However, from 1957 onwards importations of Rhodesian tobacco commenced and increased rapidly to 8% of the total. A comparison of activities indicates this may well have caused the increasing lung cancer figures from 1961. The corresponding figures for Australia show no suggestion of a plateau, but have continued to rise steeply. The use there of Rhodesian tobacco has declined but there has been a steady, more than compensating increase of use of North Queensland very radioactive tobaccos. The relative lung cancer rates for the United Kingdom, Australia, New Zealand, and Canada show a correspondence when per capita consumption is taken into account and the proportions of more radioactive tobacco in the blends. (BBB)

6620 FACTOR IN SERUM INHIBITING BONE MARROW MITOSES AFTER X-IRRADIATION OF THE SPLEEN. Dalos, B. (National Research Inst. for Radiobiology and Radiohygiene, Budapest). Nature, 212: 1252(Dec. 10, 1966).

Rabbits exposed in air to local x-irradiation of the spleen (400 R) were used to demonstrate the presence of a radioinduced antimitotic in the circulating blood and in serum. Intramuscular injection of serum from rabbits with locally irradiated spleen depressed the number of reticulocytes in the blood, a decrease that was maximal 1 to 2 days after serum injection. (H.G.D.)

6621 EXPERIMENTAL STUDIES ON LEUKEMOGENESIS IN MICE. PART II. EFFECTS OF THYMECTOMY AND SPLENECTOMY ON THE INCIDENCE OF LEUKEMIA FROM X IRRADIATION OF RF MICE. Kunisada, Mineo (Okayama Univ. Medical School, Japan). Okayama Igakkai Zasshi, 77: 1169-73(Sept. 1965). (In Japanese).

The role of the spleen and thymus in radiation-induced leukemia was studied in RF mice exposed to x rays and submitted to splenectomy and/or thymectomy. Leukemia was induced in 77% of the intact mice by a single x-ray dose of 350 R, delivered by 200-kV x rays at a dose rate of 33.5 R/min. Lymphocytic leukemia was considered in terms of a thymic and a nonthymic type. Thus thymectomy inhibited development of the thymic type of lymphocytic leukemia. Splenectomy inhibited appearance of the nonthymic type. The cells of these two organs are, it is suggested, those most susceptible to leukemogenic transformation under the effect of ionizing radiation. Of eight mice submitted to both thymectomy and splenectomy, none underwent x-ray-induced leukemogenesis. (BBB)

6622 SOME SEROLOGICAL PECULIARITIES IN RATS INTOXICATED BY CARBON TETRACHLORIDE. Hoenig, V.; Hoenigova, J. (Karlovy Univ., Prague). Tijdschr. Gastro-Enterol., 7: 277-81(1964).

The effect of x irradiation on the development of autoantibodies to liver tissue injured by carbon tetrachloride poisoning was studied. Complement was fixed by the serum of CCl_4-intoxicated rats, in the presence of extracts of rat or human liver. This has been considered an immunological reaction between the tissue antigen and the autoantibodies produced against the CCl_4-damaged liver. It was shown that in mixtures of rat liver extract and sera giving a high titer of CF, there was no hemagglutination, in the passive cutaneous anaphylactic reaction employing liver extract mixed with Evans blue as antigen and positive sera presumed to contain antibodies, in no instance did a blue spot appear at the site of serum injection, and giving of CCl_4 with Freund adjuvant did not enhance the titers, or prolong the duration of the CFR. These results suggested that when serum from CCl_4-treated rats is incubated with rat liver extract, the fixation of complement reflects a reaction other than an immunological reaction. On the other hand, an immunological character of this reaction is suggested by the observation that x irradiation of rats preceding CCl_4 intoxication abolishes the complement-fixing properties of the sera. It was demonstrated that most of these observations may be reproduced in vitro; therefore, the absolute character of an immunological reaction is lost. When the behavior of liver slices from normal rats, incubated in saline for 60 min at room temperature, was examined, complement fixation by the supernatant from these slices in the presence of liver extract was obtained. Complement fixation also occurred with human sera treated by physical procedures, such as by ultrasound, heating, and evaporation in the presence of liver extract. Previous x irradiation of the inactivated and ultrasound treated sera reduced significantly the titer of the CFR. These observations suggest that phenomena considered as immunological may be due to simple physical or physico-chemical mechanisms. (BBB)

6623 ON THE MECHANISM OF "HOMOLOGOUS DISEASE" IN SUBLETHALLY IRRADIATED MICE. Silobreic, V.; Trentin, J. J. (Baylor University Coll. of Medicine, Houston, Tex.). Transplantation, 4: 719-31(Nov. 1966).

Lethal "homologous disease" had been produced in (CBA × T6)F_1 mice within 21 days by sublethal irradiation and injection of C57BL spleen and lymph node cells. Groups of injected recipients were sacrificed at regular intervals to provide material for serial histology and for quantitative estimation of donor and host-type dividing cells in the spleen (by T6 marker-chromosome technique). The results indicate that injected C57BL cells proliferate very intensively in the spleen of sublethally irradiated (CBA × T6)F_1 hosts, so that from day 5 after injection throughout the observation period (5 to 21 days) practically all dividing spleen cells are of C57BL origin. Parallel histological examinations of the spleen disclosed an initial, massive proliferation of blast cells followed by a quite sudden decrease in their number. This eventually resulted in a typical picture of a severe lymphoid atrophy in succumbing mice. The results are discussed with regard to the possible mechanism of lethal homologous disease in sublethally irradiated mice injected with homologous cells. (auth)

6624 EFFECT OF PHYTOHEMAGGLUTININ-M (PHA) ON THE SPLEEN-COLONY-FORMING CAPACITY OF MOUSE LYMPH NODE AND BLOOD CELLS. Micklem, H. S. (Medical Research Council Radiobiological Research Unit, Harwell, Eng.). Transplantation, 4: 732-41(Nov. 1966).

The i.v. injection of 0.3 ml of phytohemagglutinin into mice led to an increase in the number of spleen colony-forming units (i.e., hematopoietic stem cells) circulating in the blood 72 hr later. There was also some small increase in the ability of lymph node cells from similarly treated mice to form spleen colonies after injection into irradiated syngeneic recipients. Of 14 lymph node-derived colonies 11 were erythropoietic and 3 granulopoietic. No "lymphopoietic" colonies were observed, although lymph node cells from both phytohemagglutinin-treated and normal mice repopulated the spleens of the irradiated recipients in a more diffuse fashion. The other detected sequelae of phytohemagglutinin injection were extensive hepatic necrosis in more than half the recipients and a slight leukopenia. Cardiac blood drawn from normal mice in the afternoon contained significantly fewer leukocytes and colony-forming units than blood drawn in the morning. No evidence was obtained in favor of the view that spatially circumscribed,

separable clones of lymphoid cells can develop in the recipients of lymphocytes from phytohemagglutinin-treated donors. (auth)

6625 REGENERATION OF BONE MARROW CELLS IN RATS FOLLOWING CYCLOPHOSPHAMIDE OR TOTAL BODY IRRADIATION. Hoest, Herman (Hydro's Inst. for Cancer Research, Oslo). Acta Radiol. Therapy, Phys., Biol., 4: 337-52 (Oct. 1966).

Comparative studies of the effect of cyclophosphamide or whole-body irradiation on bone marrow cells were performed in rats. The recovery of erythropoiesis was the same after the two types of treatment, whereas differences were evident in the pattern of myeloid regeneration. It is suggested that the stem cells are less damaged by cyclophosphamide than is the dividing compartment, whereas the reproductive integrity of the stem cells is still reduced after cessation of the radiation-induced mitotic block. (auth)

6626 VARIATION IN THE RADIOSENSITIVITY OF THE CELL POPULATION IN DEVELOPING RAT RETINA. Denham, Sylvia (Strangeways Research Lab., Cambridge, Eng.). Brit. J. Radiol., 39: 844-52(Nov. 1966).

An autoradiographic study was made of the effects of a single dose of 160 R x rays on the neural retina of two-day-old rats. In rats killed at intervals until 72 hours after exposure, accumulation of degenerate cells was maximal from 15 to 25 hours. Cells labeled with tritiated thymidine half an hour before irradiation accounted for only about 10% of the necrotic population six hours after exposure, but their incidence increased to around 25% by 30 hours. Retinal cells in the phases S, G1, and G2 + M of the generation cycle, the durations of which were previously determined, were labeled with tritiated thymidine before irradiation in each of three groups of rats that were killed six hours after exposure. Comparison of the yield of labeled degenerate cells from each group of animals revealed that the DNA-synthetic phase was least and G2 + M most sensitive to 160 R x rays, the latter having five times the sensitivity of the S phase. Over 50% of the radiosensitive cells came from the nonproliferative part of the retinal population. (auth)

6627 RECOVERY FROM X-RAY DAMAGE TO THE LENS. THE EFFECTS OF FRACTIONATED X-RAY DOSES OBSERVED IN RABBIT LENS EPITHELIUM IRRADIATED IN VIVO. Ramsell, T. G.; Berry, R. J. (Oxford Univ. Churchill Hospital, Oxford). Brit. J. Radiol., 39: 853-8(Nov. 1966).

The effects of fractionated x ray doses (1000 rad) were investigated in the lens of Dutch rabbits. Recovery was observed between two x-ray doses, using the number of broken cells per half lens fixed and stained 14 days after the first x-ray dose as the biological criterion of damage. A peak-and-trough recovery pattern similar to that seen in single-cell systems was apparent, but no recovery was noted between two 500-rad x-ray doses until they were spaced more than six hours apart; the maximum first peak of the recovery curve was seen at eight hours separation between doses. A total of 1,200 rads in two fractions eight hours apart produced virtually the same number of broken cells as a single dose of 1,000 rads. (H.G.D.)

6628 CHEMICAL PROTECTION OF IRRADIATED MONKEYS IN COMBINATION WITH AUTOLOGOUS AND HOMOLOGOUS MARROW TRANSFUSION. Whitcomb, Walter H.; Young, Robert J.; Melville, George S. Jr.; Pitcock, James A.; Anderson, Donald R. (Univ. of Texas, Austin, School of Aerospace Medicine, Brooks Air Force Base, Tex.). Radiat. Res., 29: 339-53 (Nov. 1966).

Thirty-two rhesus monkeys were x irradiated (900 R, total body) and given autologous and homologous marrow transfusions with and without prior administration of a chemical protection mixture (AET–cysteine–Nembutal). Survival times were greatest among the animals that received chemical protection plus autologous cells. No difference was observed for those animals receiving protection plus homologous cells when compared to those receiving homologous cells only. When the former group is compared to animals receiving chemical protection only, survival time is found to be shortened as a result of secondary disease. No difference in leukocyte regeneration was observed between autologous marrow recipients with or without protection. No effect of the protective mixture on the time of recovery of mononuclear cells was observed in autologous marrow recipients. Anemia was most severe in the homologous marrow recipients showing donor RBC proliferation and is presumed to be due to hemolysis associated with the secondary disease. Serum glutamic transaminase was found to be elevated in all animals receiving homologous cells and surviving to the fifteenth day with and without chemical protection. (auth)

6629 ROLE OF THE OLFACTORY BULBS IN X-RAY DETECTION. Brust-Carmona, H.; Kasprzak, H.; Gasteiger, E. L. (Cornell Univ., Ithaca, N. Y.). Radiat. Res., 29: 354-61(Nov. 1966).

It has been demonstrated that the olfactory bulb plays an important role in x-ray detection; our studies corroborate this finding and further define this role. Normal and olfactory bulbectomized rats were trained to press a lever for a 10% saccharin solution. After achieving a constant lever-pressing rate, they were repeatedly x irradiated during performance at 0.2 R/sec for 15 seconds. Control rats ceased pressing during the initial exposures but soon became habituated, while bulbectomized rats continued to press during irradiation. In a conditioned suppression experiment with electric shock as the unconditioned stimulus and x irradiation as the conditioned stimulus, normal rats learned the correct response (cessation of lever pressing during irradiation) while bulbectomized rats did not. To demonstrate that the difference between the two groups was only in their ability to detect x rays, a second conditioned suppression experiment was carried out with the same animals and conditions except that a buzzer replaced irradiation as the conditioned stimulus. Both groups were readily conditioned. (auth)

6630 RECUPERATION FROM LETHAL INJURY BY WHOLE-BODY IRRADIATION. II. KINETIC ASPECTS IN RADIOSENSITIVE BALB/c MICE, AND CYCLIC FINE STRUCTURE DURING THE FOUR DAYS AFTER CONDITIONING IRRADIATION. Kallman, Robert F.; Silini, Giovanni; Taylor III, Howard M. (Stanford Univ., Palo Alto, Calif.). Radiat. Res., 29: 362-94(Nov. 1966).

Mature male or female BALB/c mice were x irradiated, whole-body, either with single doses of short duration or with graded series of second doses at different times after three conditioning doses (D_c) — 309, 154, or 50 R. Second doses were administered every 3 hours during the first 12 hours, and every 6 to 12 hours thereafter. The LD_{50}'s were determined from the mortalities for the 30 days after irradiation, and these data were used for the calculation of residual injury —, that fraction of the D_c still effective at time t. All the D_c's induced a state of refractoriness relative to the radiosensitivity of unirradiated controls. This occurred at approximately 6 to 9 hours postconditioning and was succeeded, at approximately 9 to 15 hours, by an increase in radiosensitivity. The data were suggestive of a continuation of this initial radiosensitivity fluctuation during the 12- to 48-hour post-conditioning period. Additional experiments examined possible cyclic fine structure during recuperation. After exposure of both C57BL and BALB/c mice to conditioning doses of 150 and 300 R, groups of 16 mice were irradiated with a constant second dose at 1½ hour increments thereafter. The resultant 30-day mortalities of these groups were analyzed for minima and maxima and were subjected to time series analysis with the aid of a computer. Periodic fluctuations were detected by both techniques of data evaluation. It was concluded that conditioning doses of 150 to 300 R initiate cyclically fluctuating radiosensitivity changes which are characterized by a period of approximately 8 hours during the first 48 postconditioning hours. Evidence indicates the presence of a higher frequency cycle of approximately 4.6 hours during the third and fourth postconditioning days. Demonstration of "over-recovery," consistent with the observations of others was observed. The findings may be interpreted on a cellular basis: The observed radiosensitivity differences result from synchronization in the postirradiation growth of surviving hemopoietic stem cells in the bone marrow. In addition to killing some cells immediately, it is suggested that conditioning irradiation imposes temporary delays on the progress of surviving cells, causing them to be grouped in relatively synchronous pulses or cohorts which then assume different radiosensitivities according to their generation stage-sensitivity dependence. Thus, the approximately 8-hour cycle may be regarded as a reflection of the normal generation time of hemopoietic stem cells, and might represent half the generation cycle time of a cell regarded as having two resistant peaks, or, alternatively, the total mean generation time of cells having but one resistant peak. (TCO)

6631 EFFECTS OF VARIOUS GASES WITHIN THE NASAL CAVITIES OF RATS ON THE RESPONSE OF OLFACTORY BULB NEURONS TO X-IRRADIATION. Cooper, G. P.; Kimeldorf, D. J.; McCorley, G. C. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 29: 395-402(Nov. 1966).

Extracellular microelectrode recordings were made from single neurons of the olfactory bulb in anesthetized tracheotomized rats. Air, oxygen, argon, and nitrogen were perfused through the nasal cavities in order to determine whether the response of olfactory bulb neurons to x rays was dependent on the particular gas present within the nasal cavities. Head-only x irradiation (250 kVp, 100 R/min) produced responses in many neurons during the perfusion of all four gases used. Such responses were ordinarily depressed, however, during argon or nitrogen perfusions as compared with the responses obtained during air or oxygen

perfusion. In some cases, argon and nitrogen abolished the response to radiation within 5 minutes. It was concluded that the response of olfactory bulb neurons to x rays was not completely dependent on the presence within the nasal cavities of any particular gas. Since the response to irradiation could be modified in most cases by argon and nitrogen, it was also concluded that the response of olfactory bulb neurons depends on an effect on olfactory receptors. (auth)

6632 EFFECTS OF TOTAL-BODY X-IRRADIATION ON PERITONEAL CELLS OF MICE. Kornfeld, Lottie; Greenman, Vivian (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 29: 433-44(Nov. 1966).

Total-body x irradiation was found to alter the number and distribution of cells in the peritoneal cavity of unstimulated LAF_1 mice. Unirradiated controls yielded 6 to 8×10^6 mononuclear cells, about 30% of which were macrophages, and 70% small and medium lymphocytes. After exposure to a wide range of x ray doses (90 to 1190 R), macrophage counts remained essentially unaltered or decreased gradually to about 50% of the control value. The number of lymphocytes in the peritoneal cavity decreased sharply within 24 hours after every dose employed and then declined further at a more gradual rate. Both the initial and the subsequent disappearance of lymphocytes increased in severity with increasing exposure. During the first week postirradiation, a linear relation existed between the percentage of lymphocytes in the peritoneal cell population and the x ray dose. After all the exposures used, the loss of lymphocytes was several times as great in the peripheral blood as in the peritoneal cavity. However, peritoneal lymphocytes could be divided on the basis of size into two cell populations which differed in their response to total-body x irradiation. The small peritoneal lymphocytes were more sensitive and disappeared to essentially the same extent as circulating lymphocytes. Medium peritoneal lymphocytes were affected significantly less. (auth)

6633 MICROANGIOGRAPHIC STUDIES ON CHANGES IN THE CEREBRAL VESSELS AFTER IRRADIATION. II. PROTON BEAM LESIONS IN THE RAT. Hassler, O. (Univ. of Umea, Sweden. Univ. of Uppsala). Acta Radiol. Therapy, Phys., Biol., 4: 394-400(Oct. 1966).

Twenty-six rats received a high, localized dose of protons to the brain and were examined 10 to 360 days later by microangiography. Necrosis occurred 15 days or more after irradiation and was accompanied by increased vascular permeability. Telangiectases were observed later, being found in all animals killed 90 days or more after irradiation. (auth)

6634 X-RAY SENSITIVITY DURING THE CELL GENERATION CYCLE OF CULTURED CHINESE HAMSTER CELLS. Sinclair, W. K.; Morton, R. A. (Argonne National Lab., Ill.). Radiat. Res., 29: 450-74(Nov. 1966).

The x-ray sensitivity of cultured Chinese hamster lung cells as a function of stage in the generation cycle has been described. Previous work with a cell population partially synchronized by selection of cells at or near division has been improved by removing from stages other than the S period, resistant S cells. An exposure of about 1 hour to 20 μCi of high-specific-activity ^{3}H-thymidine per milliliter was used. A modification of the procedure also enabled the sensitivity of mitotic cells to be determined. A more accurate description of the variation in x-ray sensitivity throughout the cell generation cycle is now possible. The data presented here show that mitosis and G_2 are the most sensitive stages, followed in order of decreasing sensitivity by G_1, then by early S, and finally by late S. The rate of change of sensitivity of cells entering S is much less than the rate of change of sensitivity of cells leaving S. The survival curves indicate that not only the shoulder but also the slope varies throughout but in a similar manner. One of the most interesting new features is the almost complete absence of any shoulder in the survival curves of G_2 and mitotic cells. The use of ^{3}HTdR increases the variability of results from experiment to experiment. Results were still consistent with those obtained in asynchronous populations. In spite of an apparent association between x-ray survival and DNA synthesis, no direct correlation between number of cells in synthesis or rate of DNA synthesis with survival was noted. (auth)

6635 RECOVERY OF RAT INCISOR DENTIN FROM ABNORMAL MINERALIZATION PRODUCED BY STRONTIUM AND FLUORIDE. Yaeger, James A. (Univ. of Illinois, Chicago). Anat. Rec., 154: 661-73(Mar. 1966).

To study the ability of dentin in rat incisors to recover from the abnormal pattern of mineralization produced by fluoride and strontium, rats were injected with 5 mg NaF/100 g or 125 mg $SrCl_2$/100 g, and were killed at intervals of 4, 6, 12, and 24 days after injection. Other animals received pairs of injections, separated by intervals of four or nine days. One maxillary incisor from each animal was embedded in methacrylate, sectioned transversely, and microradiographs prepared. The other incisor was demineralized, sectioned, and the sections stained with histochemical methods for polysaccharide-protein complexes. In the microradiographs, the abnormally mineralized layers of dentin produced by the injections became less distinct as they aged. This recovery was detectable in all animals within two weeks after injection. The histochemical changes were less marked, but the weakly stained (hypomineralized) layers of matrix became more nearly normal as recovery occurred. Apparently, fluoride accelerates the maturation (secondary mineralization) of a thin layer of dentin, while both fluoride and strontium inhibit primary mineralization of predentin. In time, mineralization in the hypomineralized layers overtakes the normally mineralized dentin, and the normally mineralized dentin overtakes the hypermineralized layers. In demineralized sections stained with dialyzed iron-ferrocyanide, the responses to strontium were more variable than the responses to fluoride. Some evidence of recovery was evident at six days after strontium injection, but at 12 and 24 days the presence of intensely stained layers of dentin obscured whatever changes had occurred in the hypomineralized layer. (BBB)

6636 FETAL AND GONADAL HAZARDS FROM X-RAY STUDIES. Trautmann, J. (Roentgeninstitut des Staedtischen Krankenhaus Moabit, Berlin). Z. Aerztl. Fortbild. (Berlin), 54: 328-45(Apr. 1965). (In German).

In comparison to background radiation, the burden from artificial radiation is very small, and altogether the danger from radiation is small in comparison to other hazards of civilization. The gonads are particularly endangered by x-ray studies of the pelvis, kidneys, and abdomen. Hospitals and physicians in private practice should both be concerned with the problem of avoiding excessive irradiation of the gonads. Fluoroscopies carried out from beneath the examination table with old equipment are dangerous to the physician and other personnel, particularly when used inappropriately. The gonadal dose from intestinal contrast studies is especially high. Fractionated, small doses are considerably less injurious than single, large doses. It cannot be stated definitely that first or second generation progeny are injured, but recessive mutations may be produced. After high doses the egg cell or sperm may produce an embryo, but it generally dies before implantation. Even small doses given before fertilization may cause death. Generally, the specific radiation effects produced on the fetus depend on the stage of development. Resorption and death of the fetus, or brain hernias result from early irradiation. Brain and skeletal malformations, and increased newborn mortality result from midterm irradiation. However, exact analysis of irradiation injury effects will require many more extensive studies. (BBB)

6637 GRANULOMAS CAUSED BY THOROTRAST. van der Wouden, A. Ned. Tijdschr. Geneesk., 109: 2319-20(Nov. 27, 1965). (In Dutch).

Two patients are described with tumors in the neck as a result of Thorotrast, used for carotid angiography 20 yr previously. Both patients had large masses of contrast material in the region along the common carotid artery. A biopsy showed a sclerotic granuloma containing Thorotrast particles and hyaline. After four weeks a large ulcer had appeared; in the caudal end of the granuloma, white masses were visible. The tumor appeared to consist of friable material. Myositis ossificans, tuberculosis of the spinal cord with paravertebral calcification, and accumulation of Thorotrast in the reticuloendothelial system were observed in both patients. Complete removal of the granuloma was difficult; melignant degeneration of surrounding tissue may have occurred with a latent period of 10 to 20 years. A sample of the tumor removed from one patient was found to contain 0.00294 μC/g which would have irradiated the patient with ~20,000-R α, 70-R β, and 20-R γ doses of radiation per year; the α irradiation of cells may have been largely prevented by hyaline changes. The tissue response was related to the concentration, not the total amount of Thorotrast. (BBB)

6638 SOFT-TISSUE RADIOLOGIC TECHNIQUE FOR THE DIAGNOSIS OF PLACENTA PREVIA. Stevenson, Charles S. (Wayne State Univ., Detroit). Clin. Obstet. Gynecol., 9: 75-92 (Mar. 1966).

Possible hazards of x-ray detection of placenta previa are assessed. The usual roentgenographic exposure in the soft-tissue technique for placenta previa requires the delivery of a skin dose of about 1 R to the mother's skin for each film taken. When the current technique of very short (0.1-sec) exposure time is used and only 2 films are made, the total dose to the skin will be 1.5 to 2 R. Only part of this amount, probably less than 1 R, would pass into the mother's body and be delivered to the fetus and its gonads. Thus, it is unlikely that this small dose could have any deleterious effect on the fetus. The opinion of some roentgenologists on this point is considered. The genetic effect on subsequent generations is so slight, and (as seen from animal experiments) takes so many

generations to appear, that even theoretically, in the random breeding of a human population, it is not detectable. Nevertheless, it is important not to permit the taking of a single unnecessary film. Soft-tissue placentographic and cystographic x rays of the pregnant uterus taken in the third trimester of pregnancy can give an accurate diagnosis of the presence or absence of placenta previa in 98% of cases. The routine use of these x-ray studies in cases of placenta previa allows the achievement of a maternal mortality rate of almost zero and a perinatal fetal mortality rate of 15% or less. (BBB)

6639 GROSS EFFECTS OF GAMMA RADIATION ON THE INDIAN-MEAL MOTH AND THE ANGOUMOIS GRAIN MOTH. Cogburn, Robert R.; Tilton, Elvin W.; Burkholder, Wendell E. (Dept. of Agriculture, Fresno, Calif.). J. Econ. Entomol., 59: 682-5(June 1966).

As part of a program to develop data on radiosusceptibility of various stored-product insects, studies were conducted on the gross effects of γ radiation on the Indian-meal moth, Plodia interpunctella, and the Angoumois grain moth, Sitotroga cerealella. All metamorphic stages of the insects were treated with 13.2, 17.5, 25, 45, or 100 krad of ^{60}Co γ radiation. Weekly observations were made to check mortality, metamorphosis, and reproduction of treated individuals and their first-generation progeny. Eggs of both species and larvae of the Indian-meal moth were effectively controlled by all doses tested. Larvae of the Angoumois grain moth were controlled by all doses except 13.2 krad, which permitted some larvae to develop to the adult stage and reproduce. The life of insects treated as adults or as pupae was not greatly shortened by the treatments, but the incidence of sterility and a marked reduction in progeny produced per pair of moths varied directly with the dose applied. Genetic damage, as evidenced by reduced reproduction, was transmitted to the F_1 generation. When treated directly, males of both species were less subject to genetic damage than females; however, the progeny of treated males were more subject to genetic damage than progeny of treated females. A dose of 17.5 krad was found to be sufficient for elimination of hidden infestations of eggs and young larvae of both species in packaging plants. (BBB)

6640 PROBLEM OF DEVELOPMENTAL ANOMALIES. Horn, B.; Csordas, T.; Doemoetoeri, J.; Kiszel, J. (Women's Clinic, Budapest Univ.). Zentralbl. Gynaekol., 87: 1180-9 (1965). (In German).

Even relatively small doses of irradiation produce injurious chromosomal effects. For this reason x-ray examination of the abdomen during the first four months of pregnancy should be avoided if possible. This is particularly important because so far it has not been possible to evaluate the least amount of irradiation that might be harmful. A single x-ray examination of the abdomen may deliver as much as 0.5 to 2 R to the embryo. As reported by a patient who had worked during her entire pregnancy at a factory that manufactured measurement instruments she had been exposed to electromagnetic radiation regularly. This patient gave birth to a malformed infant. Although this case is questionable as far as any direct connection between the irradiation received and the developmental anomaly is concerned, it deserves mention because in this case, there is no other anamnestic indication of a cause other than the irradiation purportedly received. (BBB)

6641 THE RISK OF DAMAGE TO THE FIRST SUCCEEDING GENERATION (F_1 GENERATION) FOLLOWING GONADAL IRRADIATION. Kepp, R. (Univ.-Frauenklinik, Giessen, Ger.). Landarzt, 40: 1541-5(Dec. 31, 1964). (In German).

In humans the greatest risk of damage to the first succeeding generation is not an increased risk of malformed offspring, but a shift in the sex ratio. Usually, as studies of groups of irradiated patients, x-ray technicians, and radiologists indicate, there is some tendency for an excess of male offspring to be born in the F_1 generation. There is also some tendency for greater numbers of stillborn to be present in irradiated populations. This has been noted for groups of patients clinically irradiated and for populations exposed to irradiation from nuclear explosions, who received between 200 and 300 R. No differences in the number of stillborn were detected for parents who received between 100 and 150 R. These results suggested that some lethal mutations were induced in the X chromosomes, which were dominant in the progeny of the men and recessive for the women irradiated. However, it seems that the provisions of current regulations for radiation protection are several orders of magnitude less than the amounts of irradiation that appear to cause any changes in the sex ratio or the incidence of stillborn infants. There is no question that they provide ample protection against the possibility of any increase in the numbers of malformed infants. (BBB)

6642 FIRST CASE OF INTRAUTERINE ENCEPHALOPATHY CAUSED BY IRRADIATION. Bugyi, B.; Kunstadt, J. (Jan Safarik Univ., Kosice, Hungary). Acta Morphol. Acad. Sci. Hung., Suppl. 13: 43(1965).

A case of radiogenic embryopathy, supposedly the first to be reported in the world literature, is described. Toward the end of the 19th century, a radiologist studied the development of the vertebral column in his pregnant wife, who was later delivered of an imbecilic son afflicted with perinatal encephalopathy. The child exhibited no somatic anomalies with the exception of anisocoria. It is concluded that imbecility resulted from radiogenic encephalopathy since other children previously born to the couple were normal. (TSS)

6643 TERATOGENIC EFFECT OF IONIZING RADIATION. Czeizel, E. (National Inst. of Public Health, Budapest). Acta Morphol. Acad. Sci. Hung., Suppl. 13: 42(1965).

Pregnant rats were irradiated with 300 to 500 R ionizing radiation. Irradiation on the 1st day after mating caused a decrease in the incidence of pregnancy and the number of live healthy fetuses. Irradiation on the 10th day of pregnancy decreased the number and weight of fetuses per mother and caused the development of craniocerebral anomalies in some of the animals. Irradiation on the 16th day did not induce any visible abnormality. The direct effect of radiation was responsible for the injuries. If high doses are given in the early period of pregnancy, the mother's radiation injury may also play a part in the fetal damage. In this indirect effect, radiotoxins seem to play a subordinate role. (BBB)

6644 EFFECT OF FIELD SIZE ON ULTRAVIOLET MINIMAL ERYTHEMA DOSE. Olson, Robert L.; Sayre, Robert M.; Everett, Mark Allen (Univ. of Oklahoma, Oklahoma City). J. Invest. Dermatol., 45: 516-19(Dec. 1965).

To determine the effect of field size on the uv production of perceptible skin erythema, a study was undertaken in humans. A mercury arc lamp was used to irradiate the abdominal skin of 8 medium-complexioned, Caucasian subjects not recently exposed to light. The smallest amount of energy producing an erythema at eight hours was recorded as the minimal erythema dose (MED). Field size varied from 0.1 mm by 1 cm to 4 cm by 4 cm. The experiment was repeated with monochromatic light from a xenon arc monochromator to ascertain if a wavelength relation to field size and MED existed. The wavelengths 254, 280, and 297 μ were studied. An inverse relation was shown to exist between field size and MED. A small field required a larger amount of energy to produce erythema than a large field. This relation exists whether polychromatic or monochromatic light is employed. Other factors known to influence the erythema response include skin color, previous light exposure, anatomic site of irradiation, and time factors. Failure to control one or more of these variables reflects upon the results obtained. (BBB)

6645 THYROID CARCINOMA AND ROENTGEN IRRADIATION. EARLY DIAGNOSIS AND TREATMENT. van Slooten, E. A.; Frenkel, M.; Delemarre, J. F. M. Jaarb. Kankeronderz. Kankerbestrijding Ned., 14: 43-9(1964). (In Dutch).

The role of childhood irradiation on subsequent development of thyroid carcinomas is discussed. Carcinogenesis in such cases is dependent upon age at exposure, the incidence decreasing with increase in age. Latent development of a well-differentiated tumor is characteristic. The metastatic pattern generally includes the throat and upper mediastinum. Methods for determining individual susceptibility are considered. (TSS)

6646 FUNCTIONS OF THE THYMUS SYSTEM AND THE BURSA SYSTEM IN THE CHICKEN. Cooper, Max D.; Peterson, Raymond D. A.; South, Mary Ann; Good, Robert A. (Variety Club Heart Hospital, Minneapolis). J. Exp. Med., 123: 75-102 (Jan. 1, 1965).

Surgical removal from newly hatched chickens of the bursa of Fabricius and thymus (central lymphoid organs in the chicken essential to the ontogenetic development of adaptive immunity) was followed by sublethal x-irradiation the next day. This permitted recognition of two morphologically distinct cell systems in the peripheral lymphoid tissues of the spleen, gut, and other organs, and definition of the separate functions of each cell system. The radiation dose was 650 R; the $LD_{50/21}$ value in this species was 750 R. Thymectomized-irradiated chickens were deficient in all cellular-immunity responses. Growth was inhibited, but germinal centers, plasma cells, and capacity for immunoglobulin synthesis remained intact. Bursectomized-irradiated chickens were agammaglobulinemic and unable to produce detectable antibody despite intense, repeated stimulation with bovine serum albumin and Brucella abortus. The thymus-dependent development in these animals appeared to be normal. Shortened life span precluded adequate study of responses of delayed hypersensitivity. There was no evidence of significant impairment of reticuloendothelial function in either the bursectomized-

irradiated or the thymectomized-irradiated group, as judged by the clearance of colloidal ^{198}Au and ^{131}I-tagged keyhole limpet hemocyanin. (TSS)

6647 IMMUNOLOGIC COMPETENCE OF MOUSE PLACENTAL CELLS IN IRRADIATED HOSTS. Dancis, Joseph; Douglas, Gordon W.; Fierer, Joshua (New York Univ., New York). Amer. J. Obstet. Gynecol., 94: 50-6(Jan. 1, 1966).

Evidence for immunological competence in placental cells was sought by transferring these cells to irradiated mice of another strain. This experimental situation is known to produce illness and death in the recipient mouse as a result of a graft-vs-host reaction. Irradiated male recipients were injected with bone marrow and/or placental cells at intervals of about 15 min about one hr following x irradiation with 800 R. The intraperitoneal injection of placental cells from C57B1/6J mice into newborn Balb/C mice was relatively innocuous, although the intravenous route produced a significant mortality. A higher mortality was induced when A/Heston mice were used as recipients. When suspensions of 10 million C57B1/6J placental cells were injected into three-month-old C57B1/6J and CBA mice following irradiation with 800 R, life span was decreased by allogenic placental cells but isogenic placental cells had no effect or possibly afforded a small degree of protection. When CBA mice were irradiated with 800 R and injected intravenously with 2 million isogenic bone marrow cells, allogenic placental cells increased the mortality rate, while the isogenic placental cells had no effect. In three-month-old CBA mice irradiated with 800 R and injected with 20 million bone marrow cells from C57B1/6J mice, the addition of 10 million allogenic placental cells increased the mortality rate. Thus allogenic placental cells enhanced mortality in irradiated recipients. The survival time of irradiated mice that had received isogenic or allogenic bone marrow was also abbreviated by allogenic placental cells. The lack of effect of isogenic and F_1 placental suspensions indicate that the lethal effect of allogenic placenta involves a genetic difference, suggesting a graft-vs-host reaction. It was concluded that immunologically competent cells are contained within the placenta, but whether they are of trophoblastic or mesenchymal origin is presently unknown. (BBB)

6648 ACTION OF RADIATIONS ON THE CENTRAL NERVOUS SYSTEM. I. CHANGES IN CHOLINESTERASE. Abbadessa, S.; Avellone, S.; La Grutta, G. (Univ., Palermo, Italy). Boll. Soc. Ital. Biol. Sper., 41: 1408-11(Oct. 31, 1965). (In Italian).

Changes in cholinesterase activity in brain tissues were investigated in rabbits 12 hr after x irradiation with a single dose of 1000 R. The enzyme was examined in tissue taken from the cerebral cortex, from the basal nuclei of the brain, and from the cerebellum. Erythrocyte and plasma enzyme activities were also determined. Homogenates of brain were prepared in 0.025M bicarbonate buffer and assayed for both true and pseudo cholinesterase activity. True and pseudo cholinesterase activity increased 19.2 and 23.7%, respectively, in cerebral cortex 12 hr after 1000 R irradiation; these increases were statistically significant. Insignificant increases occurred in basal nuclei and in cerebellum, and insignificant decreases occurred in erythrocytes and in plasma. (BBB)

6649 GLUTATHIONE CONTENT OF SEVERAL RAT ORGANS AFTER WHOLE-BODY IRRADIATION. Rathgen, G. H. (Univ., Mainz). Arch. Gynaekol., 202: 479-81(1965). (In German).

Within 30 min after whole-body x irradiation with 800 R, changes in glutathione concentrations were observed in liver and spleen of rats. The changes involved the oxidized and reduced fractions of glutathione. In the spleen oxidized glutathione was less than half the normal value, and reduced glutathione was decreased by about 30%. A similar pattern was observed in liver for oxidized glutathione, but reduced glutathione increased by about 50%. Later, at 24 hr after irradiation the oxidized glutathione concentrations in liver and spleen were slightly increased. In spleen the concentration of reduced glutathione decreased, but in liver there were no definite changes. The decreased concentrations of glutathione observed were not due to loss into the blood, because concentrations in blood were also decreased. The increased reduced glutathione in liver was considered to be significant, because there was no increase in glutathione reductase activity resulting from whole-body irradiation. (BBB)

6650 EXPERIMENTS TO IMMUNIZE CHICKS WITH IRRADIATED SYNGAMUS TRACHEA LARVAE. Varga, Istvan (Univ. of Veterinary Sciences, Budapest). Magyar. Allatorv. Lapja, 20: 205-10(May 1965). (In Hungarian).

In previous experiments it was established that the irradiation of Syngamus larvae using at least 4000-R x-ray doses hinders the sexual maturation and localization in the trachea of worms developing from them. Further experiments were aimed at establishing whether larvae attenuated by irradiation could develop immunity in hosts. In groups of chicks, each consisting of 8 to 12 immunized and control birds, the number of developing worm pairs following challenge infection was established. In groups of chicks vaccinated once or twice at an age of one, two, or three weeks, 72 to 100% fewer worms developed as a result of the same challenge infection than in controls. In 24% of vaccinated chicks the number of worm pairs was less than in control ones and in 76% of them no worms at all developed after challenge. Positive larva precipitation tests obtained with the serum of hyperimmunized turkeys and vaccinated chicks indicated that serum antibodies may have a role in hindering the development of the worms. Chick and hyperimmunized turkey sera gave positive larva precipitation tests up to dilutions of 1:4 and 1:64, respectively. Active immunity conveyed by irradiated larvae provides proof that syngamosis is a helminthosis in which a larva migration phase, without the presence of sexually mature worms, is able to induce immunity. (BBB)

6651 FORMATION OF ANOMALOUS METABOLITES IN IRRADIATED ORGANISMS. Kryukova, L. M. Usp. Sovrem. Biol., No. 1, 62-75(July-Aug. 1965). (In Russian).

The literature on the formation of anomalous metabolites is surveyed, especially radiotoxins. In the animal organism, high doses of ionizing radiation cause anomalous metabolites to be formed. Individual studies in which no formation of radiotoxins in irradiated organisms was detected are evidently explained by the fact that an insufficiently exact procedure was used. Higher radiation doses were needed to determine various changes in plant metabolism than for animals. Observations have established the formation of radiotoxins in irradiated plants. Such anomalous metabolites not only inhibit cell division but also induce chromosome aberrations, with the appearance of bridges, fragments, and micronuclei. The nature of the anomalous metabolites is still undetermined. Possible mechanisms for radiotoxin induction are considered. Radiotoxins produced in the organs and tissues of organisms irradiated by high doses of ionizing radiation induce the same changes as the direct action of radiation, but quantitatively to a lesser degree. Radiotoxins may be of great practical value in view of their pronounced antimitotic effect with comparatively minimal general toxic properties in comparison with direct irradiation. The possibility that radiotoxins may be used to inhibit the division of malignant cells is noted. (TSS)

6652 CELL CHANGES CAUSED BY COSMIC RADIATION. Eugster, J. (Univ., Bern). Bull. Schweiz. Akad. Med. Wiss., 21: 425-6(1965). (In German).

Effect of cosmic radiation on human skin samples was studied by means of gold foils that produced intense radiation stars upon impact with cosmic particles. Ion density amounted to $\sim 10^4$ ion pairs/μm^3. Localization of the stars was ascertained by use of nuclear film. The skin tissue studied could be considered as senile or showing evidence of Bowen's disease. The average exposure time of the 33 human subjects used was 3 to 4 weeks. The exposure was performed on the Jungfraujoch. Histological changes in the skin were compared to the recorded tracks of the irradiation. In one study 9 impacts could be correlated with evidence of mutated foci. There was some evidence of back mutation within the central zones of the foci observed. (BBB)

6653 LYMPHOID CELLS OF THE BONE MARROW: PROLIFERATION, ORIGIN, AND FUNCTION. Keiser, George (Univ., Zurich). Helv. Med. Acta, 32: Suppl. 45, 103p.(1965). (In German).

Four young adult dogs were given 250 R of whole-body x irradiation. The differential picture of the lymphoid cells of the bone marrow was shifted for a period of 5 to 20 days. During this period relatively large and medium size lymphoid cells replaced the small lymphoid cells. This shift caused an increase of the index of labeling with ^3H-thymidine, and a shift of the labeling maximum to the first day. In addition, the labeling index of the small lymphoid cells increased. This was apparently due to early appearance of labeled small lymphoid cells that had a shorter generation time than cells not labeled initially, or to reduction of the numbers of long-lived small lymphoid cells by the irradiation. Apparently, there was no shortening of the average generation time of the large and medium size lymphoid cells after irradiation. The results suggested that during the early phase after whole-body irradiation there was a stimulation of stem cell function of various hematogenic lymphoid cells. It was not possible to ascertain which of the three classes of lymphoid cells were associated with the stem cell function. (162 references.) (BBB)

6654 IONTOPHORESIS OF ^{22}Na AND ^{131}I INTO THE INNER EAR. Stecker, Raymond H.; Cody, D. Thane R. (Mayo Clinic, Rochester, Minn.). Arch. Otolaryngol., 83: 213-17(Mar. 1966).

Experiments were conducted in guinea pigs to demonstrate penetration of ^{22}Na and ^{131}I into the inner ear during iontophoresis while radioactive solutions were present in the tympanic cavity. Ions of ^{22}Na and ^{131}I diffused through the intact mucous membrane of the middle ear. The concentration of the ^{22}Na and ^{131}I in the inner ear after simple diffusion was about 1% of the concentration of the test solution placed in the tympanic cavity. Iontophoresis with the anode in the test solution caused a four-fold increase in the amount of ^{22}Na reaching the inner ear as compared to that entering by diffusion alone. Varying the concentration of ^{22}Na in the test solution did not influence the percentage of ^{22}Na entering the inner ear under iontophoresis. Iontophoresis with the cathode in the test solution produced a threefold increase in the amount of ^{131}I entering the inner ear as compared to that entering by diffusion alone. The fact that only small amounts of these ions were found in the perilymph-endolymph mixture after the bulla had been filled with the ionic solutions for 30 min indicates that there is a very strong barrier to the diffusion of ions from the middle to the inner ear. (BBB)

6655 STUDIES ON IODIDE-INDUCED SIALADENITIS AND ^{131}I ACTIVITY OF THE SALIVARY GLANDS. Seifert, G.; Junge-Huelsing, G. (Univ., Hamburg). Frankfurt. Z. Pathol., 74: 485-500(1965). (In German).

Acute sialadenitis of the submaxillary was induced in rats by intraperitoneal injections of KI. The initial changes consisted of widening of the proximal interlobar ducts. This was followed by acute sialangitis, epithelial necrosis, eosinophilic cell infiltration, and acute inflammation of the parenchyma with ecinus destruction. Some of these changes were partially reversible after the I injections were halted. After intraperitoneal injection of 50 to 80 μC of ^{131}I a max concentration appeared in the submandibular gland that was greater than in the parotid and in the serum. The results of the ^{131}I measurements indicated that there was a short-term concentration and rapid loss of ^{131}I in the submandibular gland. The morphological changes were related to the I dose and the length of treatment. The epithelium of the proximal efferent ducts were the site of I concentration and excretion. The I sialadenitis represents an example of a salivary gland inflammation produced by an electrolyte shift. References cited, 46. (BBB)

6656 RELATIONSHIP OF THE NEUROMUSCULAR ELEMENTS IN THE PROCESS OF POSTTRAUMATIC REGENERATION OF IRRADIATED MUSCLE. Tuzhilkova, T. N. (Chelyabinsk State Medical Inst., USSR). Radiobiologiya, 6: 391-3 (1966). (In Russian).

The muscles of the hind limbs of rats were used in this study. The right limb was subjected to local irradiation and the left served as a control. The muscles of both limbs were cut with a razor resulting in posttraumatic regeneration. Results of the study established the following relationships. Posttraumatic regeneration of the nerve elements corresponds fully to the regeneration of the muscle elements. In the nonirradiated muscle, the earlier establishment of neuromuscular junctions ensures the most complete and rapid differentiation of the newly formed muscle fibers. In the irradiated regenerating muscle, even in the long-term period after irradiation (6 and 12 months), only a partial restoration of the neuromuscular junctions along the periphery of the regenerate is observed; in the central portion of the regenerate, the neuromuscular junctions do not appear; cholinesterase activity is not detected in the myosymplasts. The impairment of the establishment of neuromuscular junctions in irradiated regenerating muscle inhibits its regeneration, causes death of the newly formed myosymplasts, and promotes a replacement of the defect with loose connective tissue. (H.L.W.)

6657 AUTORADIOGRAPHIC LOCALIZATION IN FETAL ORAL TISSUES OF MATERNALLY STORED ^{45}Ca. Goren, Arthur; Gerstner, Robert (Coll. of Dentistry, New York Univ., N. Y.). J. Dent. Res., 44: 1272-7(Nov.-Dec. 1965).

The dose of radiocalcium per kg of body weight physiologically compatible with life, and which would yield a detectable blood isotope level, was first determined. Growing female rats received 10, 25, 40, 60, 75, and 100 μCi of ^{45}Ca per 100 g body weight. The optimal dose was found to be 25 μCi ^{45}Ca per 100 g. Immediately after administration of the 25 μCi/100 g radiocalcium to the nonpregnant animals, the blood level of the ^{45}Ca rose and continued to increase, reaching a peak on the fourth day. By the eleventh day the ^{45}Ca level of the blood was decreased to essentially background. Blood sampled at intervals during pregnancy showed no variation in ^{45}Ca levels. Fecal and urine specimens examined at this time showed that large amounts of the isotope were being excreted. Microscopic examination of radioautographs from the neonatal animals revealed deposition of ^{45}Ca in the dentin, predentin, and pre-enamel of the developing molars and incisors. The developing bone matrix was heavily infiltrated with ^{45}Ca. It was observed both in the developing ameloblasts and odontoblasts, with the highest concentration around the developing cusps of the first molars. No isotope was seen in the second molars. There also was cavitation, a sign of radiation damage to some of the secreting enamel and dentin cells, not seen in controls. (BBB)

6658 EXPERIMENTAL MODIFICATIONS OF THE KARYOTYPE IN A URODELE AMPHIBIAN (PLEURODELES WALTLII MICHAH.) BY IRRADIATION OF THE EGG AND NUCLEAR GRAFTING. Gallien, L.; Labrousse, M.; Picheral, B.; Lacroix, J. Cl. (Faculte des Sciences, Paris). Rev. Suisse Zool., 72: 59-86(1965). (In French).

Pleurodele eggs were subjected to the experimental procedures of γ irradiation and transfer of nuclei to unfertilized eggs. The eggs were irradiated using ^{60}Co. Radiation intensity was 0.5×10^{-18} ev/cm^3/hr and was conducted for periods of 30 sec, one min, or two min, during one of the principal developmental stages. Eggs destined to receive a nuclear graft were obtained from a sexually mature female, and were activated by an electrical discharge, then subjected to uv radiation for female pronucleus destruction. Under these experimental conditions, some embryos displayed atrophy with premature signs of lethality. These embryos were studied with respect to their karyotypes. Among the chromosome aberrations observed were breakages, deletions, translocations, and the presence of two centromeres per chromosome. The more representative cases were analyzed. The breakages and deletions appear to be a specific response of the chromosome to varied agents. In general, the presence of a nucleus in cytoplasm that has been altered in various ways leads to chromosomal aberrations which affect embryonic development generally in a lethal way. The fact that they do not always have an immediately lethal effect makes these analytical methods useful for studying the consequences of chromosomal aberrations on morphogenesis in amphibians. The phenomena described in these experiments are similar to those seen after various treatments in tissue culture. (BBB)

6659 CELLULAR AND MAMMALIAN RADIATION EFFECTS AND THEIR INTERPRETATION IN RELATION TO MANNED SPACE FLIGHT. Todd, Paul (Pennsylvania State Univ., University Park). Trans. Amer. Nucl. Soc., 9: 360(Oct.–Nov. 1966).

6660 ENERGY-LOSS DISTRIBUTIONS AND FRACTIONAL-CELL LETHALITY. Curtis, S. B. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc., 9: 359(Oct.–Nov. 1966).

6661 RADIATION RESPONSE OF MAN IN THE INTERMEDIATE DOSAGE RANGE. Langham, Wright H. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc. 9: 357(Oct.–Nov. 1966).

6662 MORPHO-PHYSIOLOGICAL INVESTIGATION OF THE DEVELOPMENT OF THE MOTOR FUNCTION OF CHICK EMBRYOS AFTER TOTAL GAMMA IRRADIATION. Sviderskaya, G. E. (Inst. of Evolutionary Physiology and Biochemistry, Leningrad). Radiobiologiya, 6: 423-30(1966). (In Russian).

The effects of irradiation on the development of the motor activity of chick embryos were investigated. Spontaneous and reflex movements appear later than in the control; the periods of time during which spontaneous movements are recorded in the embryos are shortened, the rate of maturation of the reflexogenic zones slows down, and the development of the nature of the reflex movements is slower. The effects of radiation depend upon the age of the embryos at the time of irradiation and are least pronounced when the embryos are irradiated during the first day of incubation. In the irradiation of one-day embryos, small changes, pertaining chiefly to the nucleus and nucleolus, as well as temporary inhibition of the mitotic process, are rapidly eliminated as a result of recovery processes, and in particular, as a result of the intensified mitotic activity. After irradiation on the fourth day, the phenomena of damage to the spinal cord are detected considerably more strongly, while restoration of the structure is less complete, since it falls at the time of a normal decrease in the general level of mitotic activity of the spinal cord. An even less complete restoration of the damaged structure is noted when the embryos are irradiated on the seventh day, when the proliferative activity of the spinal cord is normally ended. The morphological changes noted are correlated with functional disturbances of the motor activity. (TSS)

6663 VULNERABILITY OF THE RETINAL MEMBRANE OF THE EYE TO X RAYS. Marmur, R. K.; Manturo, N. A. (Odessa Scientific Research Inst. of Eye Diseases and Tissue Therapy). Radiobiologiya, 6: 431-3(1966). (In Russian).

The pathohistological changes in the retina of the rabbit, arising after irradiation of the eyes at a dose of 1 kR, are reversible. When the eye is irradiated by x rays at a dose of 5 kR, clearly

pathological, irreversible changes develop in the retinal membrane. In the case of irradiation at a dose of 10 kR, the changes that develop in the retina cover all its layers and are irreversible; partial changes in the form of edema are also noted in the nonirradiated (sympathizing) eye. (auth)

6664 CHANGE IN THE VOLUMES OF THE NUCLEUS AND CYTOPLASM OF PURKINJE'S CELLS UNDER THE INFLUENCE OF LOCAL X RAY IRRADIATION OF THE CEREBELLUM. Kantorova, V. I. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 434-9(1966). (In Russian).

Local irradiation of the cerebellum of the guinea pig at a dose of 9 kR causes a change in the volumes of Purkinje's cells and their nuclei immediately after the influence. The changes in the volumes at various periods after irradiation are phase changes, coinciding with the phases of other morphological changes in the cerebellum and the clinical state of the animal. The periods of strong changes in the structure of the cells alternate with a tendency toward restoration. However, this restoration is never complete, which leads to gradual atrophy of the cells and organ. The radiation decrease in the volumes of the nuclei and increase in the cytoplasmic-nuclear ratio are evidently signs of aging of the nerve cells surviving after irradiation. (auth)

6665 CHANGES IN DIGESTION UNDER THE INFLUENCE OF IONIZING RADIATION UPON THE ORGANISM. Gavrilov, R. I.; Domanskii, V. Yu. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Radiobiologiya, 6: 394-8(1966). (In Russian).

During total x irradiation at doses of 700 and 450 R, rats develop profound disturbances of the contact digestion in the upper portions of the small intestine. The invertase activity on the surface of the intestinal mucosa, characterizing the state of the contact digestion, drops sharply after 24–48 hours, and may be entirely absent after 72 hours. The restoration of the contact digestion begins on the fourth day after irradiation and ends on the seventh day. The enzymatic activity of a homogenate of the mucosa of the upper portions of the small intestine is reduced during the first days and drops to zero or negligibly small figures after 72 hours, after which it begins to be restored, reaching a normal or almost level by the seventh day. However, after ten to 15 days there is a new prolonged decrease in the invertase activity of the homogenate, retained over a month of observation. (auth)

6666 PECULIARITIES OF INJURY TO THE BLOOD IN RATS AT AN EARLY AGE AS A RESULT OF TOTAL X RAY IRRADIATION. Kholin, V. V.; Ivanova, T. F. (Leningrad Inst. for the Advanced Training of Physicians). Radiobiologiya, 6: 399-402(1966). (In Russian).

The presence of substantial peculiarities in the response of the peripheral blood of baby rats to x irradiation was established, in contrast to sexually mature rats. These peculiarities were expressed, on the one hand, in a more severe injury of hematogenesis in the baby rats, and on the other, in the characteristic unique dynamics of development of the response of the blood to irradiation. Pronounced and stable anemia developed in the baby rats as a result of irradiation, with a weak manifestation of anemia in the sexually mature animals. (auth)

6667 INFLUENCE OF LOCAL X RADIATION OF MEDULLA OBLONGATA ON THE CENTRAL LINK OF THE DEPRESSOR REFLEX. Balashova, A. N. (Inst. of High Nervous System and Neurophysiology, Moscow). Radiobiologiya, 6: 403-10(1966). (In Russian).

Local irradiation of the medulla oblongata of rabbits by x rays at a dose of 500 R caused a change in the functional state of the central link of the depressor reflex which was detected upon supplementary stimulation. Disturbances in the relationship of the stimulation of the depressor nerve and the arterial blood pressure were observed. The use of supplementary oxygen stimulation for the first five to seven days after irradiation caused a perversion of the reaction of the vascular center in most of the rabbits, leaving the reaction of the receptor formations of the aortic zone normal. (H.L.W.)

6668 RELATIONSHIP BETWEEN RADIATION AND FERMENTATIVE DAMAGE TO THE ERYTHROCYTE MEMBRANE OF ADULT AND NEWBORN RATS. Orlova, L. V. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 356-61(1966). (In Russian).

Various enzymes, acting upon a suspension of erythrocytes of adult rats, irradiated at a dose of 5 kR, induce varying degrees of damage to the erythrocyte membranes: ribonuclease damages the cell membrane to an extent of ~73%, lipoxidase ~26%, and trypsin ~11%. Lipoxidase exerts a greater injurious effect upon irradiated erythrocytes of newborn rats (~89%) in comparison with adults. Tyrosinase strongly damages irradiated erythrocytes of newborn rats (~217%), without exerting any injurious effect upon irradiated erythrocytes of adult animals. The damage to irradiated erythrocytes detected under the action of various enzymes may be interpreted as a specific effect of enzymes on the corresponding portions of the cell membrane. Evidently processes of oxidation of tyrosine, unsaturated fatty acids, changes in the protein portion, as well as changes in the RNA molecules may occur on the erythrocyte membrane. It is believed that the lower radiosensitivity of the erythrocytes of newborn rats in comparison with adults is due to the fact that tyrosine and unsaturated fatty acids are oxidized to a lesser degree in the erythrocyte membrane of newborn animals than in the membrane of adult rats. (auth)

6669 MECHANISM OF INJURY OF THE HEMATOGENIC TISSUE UNDER THE ACTION OF IONIZING RADIATION. Gruzdev, G. P.; Rozhdestvenskii, L. M.; Fedotova, M. I.; Shcherbova, E. N. Radiobiologiya, 6: 483-5(1966). (In Russian).

Rats and bone marrow cultures were gamma irradiated using a cobalt-60 source. Unirradiated rats and bone marrow cultures served as controls. The mitotic index and the number of cells with chromosome aberrations were used as indicators of the hematopoietic capacity of the tissue. In the control rats the mitotic index remained constant, and in the control cultures dividing cells appeared one hour after the beginning of the culture. In irradiated cultures and in bone marrow cultures from irradiated animals a delay in division at the metaphase was noted. Chromosome aberrations were much more numerous in irradiated cultures and in cultures from irradiated rats than in controls. The change in hematopoietic capacity of cells in irradiated bone marrow cultures is analagous to the change following irradiation of the whole animal. (H.L.W.)

6670 TIME DISTRIBUTION OF THE DEATH RATE OF IRRADIATED MACAQUES. Kulinskii, V. I. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR. Ukrainian Inst. for the Advanced Training of Physicians, Kharkov). Radiobiologiya, 6: 337-42(1966). (In Russian).

In concentric γ irradiation at doses of 570–930 R, the death of macaques occurred on the fifth to 22nd days, especially often on the 11th to 19th days. MLD_{100} was equal to approximately 700–720 R. No significant deviations of the empirical distributions of the death rate of irradiated macaques with time from those calculated according to a normal law of the curves were detected; a small negative asymmetry was possible. A logarithmic transformation of the periods of death does not bring them any closer to a normal distribution. At doses of 608–750 R, five to six peaks of the death rate were detected in the periods 5–7, 8–10, 11–13, 14–16, 17–19, and 20–22 days after irradiation, using three mathematical methods, which give good coincidence of the results. A circadian rhythm of the death of the irradiated macaques with a maximum in the daytime hours (8:00 AM to 4:00 PM) and a minimum in the evening hours (4:00 PM to Midnight) was established. (auth)

6671 SORPTION PROPERTIES OF INTERNAL ORGANS UNDER THE COMBINED INFLUENCE OF TOTAL GAMMA IRRADIATION AND BURNS. Stepanov, E. P. (Kharkov Inst. of Medicine). Radiobiologiya, 6: 349-52(1966). (In Russian).

The sorption of an intravital dye, neutral red, by various tissues of the rat was studied after administration of gamma radiation, burns, and a combination of radiation and burns. Results are tabulated. Under the combined influence of total gamma radiation at a dose of 400 R and thermal burn, the effect of the injurious action is intensified, which is expressed in an increase in the sorption properties of most of the investigated tissues and a slower return to normal. The increase in the sorption properties of radiosensitive tissues under the combined influence gives a basis for assuming that burn, while itself inducing no significant changes in the sorption levels of the investigated organs, in conjunction with radiation intensifies the injurious effect of ionizing radiations. (H.L.W.)

6672 INFLUENCE OF THE GAMMA IRRADIATION DOSE RATE ON THE LIFETIME OF GRANARY WEEVILS. Zakladnoi, G. A. (All-Union Scientific Research Inst. of Grain and Products of Its Processing, Moscow). Radiobiologiya, 6: 478-9(1966). (In Russian).

Increasing the dose rate accelerates the death of granary weevils. With increasing irradiation dose from 12 to 50 krad, the difference in the effect of the dose rate is leveled out at the level of 99.9% death of the weevils; however, the total effectiveness is negligibly reduced. (auth)

6673 RADIATION MYELITIS: CASE REPORT. Kozuka, Takahiro; Kawamura, Jiro; Terashita, Hiroshi (Osaka Univ.). No To Shinkei, 16: 965-9(Nov. 1964. (In Japanese).

The case history of a patient who developed severe spinal

cord injury as a result of radiotherapy is reported in detail, including a macroscopic and microscopic histopathologic study of the lesion. The 54-yr-old male with epipharyngeal carcinoma and cervical metastases had been treated with x rays, the dosage being divided into three series. Eleven months after final treatment he began to complain of hypesthesia and pain at his left hand, forearm, and lower extremity. Thereafter these symptoms gradually progressed and he developed quadriplegia, with urinary disturbances. Twenty months after onset of the symptoms he died. It was found at the autopsy that there was no metastatic tumor in the spinal canal. Microscopic examination of the cord revealed necrosis, glial cell proliferation, and demyelination at the level of the cervical cord. It is estimated that the total dose which was given to cervical spinal cord of this patient amounted to about 7000 R. Subsequently, attempts were made to avoid this complication caused by radiation treatment for malignant tumor as far as possible by means of other radiation methods such as electron beam therapy and prolonged follow-up examinations. The literature relating to previous cases of radiomyelitis and the doses used is briefly surveyed. (BBB)

6674 PARATHYROID FUNCTION AFTER ^{131}I THERAPY FOR HYPERTHYROIDISM. Adams, P. H.; Chalmers, T. M. (Addenbrooke's Hospital, Cambridge, Eng.). Clin. Sci., 29: 391-5(Oct. 1965).

An attempt was made to determine the prevalence and clinical significance of parathyroid insufficiency after ^{131}I therapy by studying parathyroid function in 60 patients who had received this treatment for hyperthyroidism. Nineteen (31%) were found to have developed hypothyroidism. The distribution of the serum calcium values in 50 control subjects and in the 60 ^{131}I-treated patients showed that the mean value for the serum calcium was the same in both groups (10 to 19 mg/100 ml). In none of the ^{131}I-treated patients was there hypocalcemia; 19 had a serum calcium level below 10 mg/100 ml. No relation was found between the serum calcium level and the type of goiter, the development of hypothyroidism, the duration after receiving ^{131}I, or the total dose of ^{131}I administered. Fifteen (25%) of the patients experienced symptoms which could be associated with parathyroid insufficiency. Most of these had depression (13) and paraesthesiae (9). There was no association between the presence of symptoms and the serum calcium level. It was previously found that some patients who had received therapeutic doses of ^{131}I developed partial parathyroid insufficiency, as shown by a subnormal increment in urinary phosphate excretion after phosphate feeding. The present investigation supports these findings. The cause of the partial parathyroid insufficiency in these patients is presumably radiation damage from the ^{131}I taken up by the thyroid gland. It was calculated that with an estimated dose of 9000 R to the thyroid it is possible for the parathyroid glands to receive a γ-ray dose of 400 to 500 R. These figures are based upon the assumption that the parathyroid glands lie on the posterior surface of the thyroid lobes, but the anatomical situation of the parathyroid glands is variable; sometimes they lie embedded within the thyroid capsule and occasionally within the thyroid substance. In these circumstances the amount of irradiation delivered to the parathyroids would be greater than calculated here. This variability in the anatomical situation of the parathyroid glands may explain the lack of correlation between the presence of parathyroid insufficiency and the amount of ^{131}I administered. By the criteria followed here, at least 10% of a group of patients treated with ^{131}I for hyperthyroidism will show evidence of a diminished parathyroid reserve. (BBB)

6675 ELECTROENCEPHALOGRAPHIC EVALUATION OF THE FUNCTIONAL CONDITION OF THE CENTRAL NERVOUS SYSTEM DURING RADIATION THERAPY IN THE MEGAVOLTAGE RANGE. Vvedenskaya, I. V.; Stepanova, T. S. Vop. Neirokhir., 29: 31-5(Jan.-Feb. 1965). (In Russian).

Effects of radiation on brain bioelectrical activity in 25 patients (12 men and 10 women 16 to 57 years old and 3 children) with brain tumors were observed while undergoing radiation treatment in the megavoltage range (25-Mev betatron). The results showed that the dynamics of bioelectrical activity can be correlated with the functional changes which develop in the central nervous system at various phases post-irradiation. After a moderate dose (2000 rad) of irradiation of the tumor, cyclic variations of biopotentials were observed, which were evident from the shift of the amplitude of reinforced hypersynchronized activity from periods of firm desynchronization of the biopotentials. Phasic changes in the functional condition of various central nervous structures were also reflected by variations of autonomic nervous system reactions. Reinforcement of arrhythmia was observed as well as changes of the breathing rhythm. On the basis of the analysis of the electroencephalograms, participation of nonspecific structures at the mesodiencephalic level in the mechanisms governing the reactions of the central nervous system to radiation effects was evident. The conclusion is drawn that regular electroencephalographic examinations of patients undergoing radiation therapy in the megavoltage range permits collecting useful information about the reactivity of different neurodynamic brain structures during the course of the radiation treatment. (BBB)

6676 THE REACTIVE OLIGODENDROCYTE: AN ELECTRON MICROSCOPIC STUDY OF CEREBRAL CORTEX FOLLOWING ALPHA-PARTICLE IRRADIATION. Maxwell, David S.; Kruger, Lawrence (Univ. of California, Los Angeles). Amer. J. Anat., 118: 437-59(Mar. 1966).

Focal lesions were produced in the cerebral cortex of 30-day-old female rats with 41.6-MeV α particles in doses of 5, 9, 12, 20, and 30 krad. Irradiation within the dose range 6,000 to 12,000 rad resulted in the production of a laminar lesion with minimal destruction of neurons in the overlying layers. Light microscopic examination of the laminar lesion zone, after a dose-dependent interval, revealed the degeneration and disappearance of all neuron perikarya. The ultra-structural features of oligodendrocytes were studied in a zone of cerebral cortex in which all neurons are destroyed and numerous processes damaged by these heavy ionizing particles. This type of lesion fails to reveal signs of vascular inflammation and classical gitter cells in light microscopy or any signs of debris fragments in electron microscopy. Oligodendrocyte satellites of neurons or their processes display an acute swelling associated with signs of neuronal damage. This is followed by a marked increase in a morphologically rich variety of dense osmiophilic organelles of granular, lamellar, crystalline, or amorphous sub-structure. Acid phosphatase activity has been demonstrated in some of these organelles, thus implying a participation in lysosomal intracellular breakdown. Invasion by microgliacytes and phagocytosis was not observed. Present evidence supports the efficacy of intracellular mechanisms in the breakdown of degenerating material and suggests a reevaluation of the evidence for identification of microglia on the basis of granular inclusions. (BBB)

6677 OBSERVATIONS ON PANCREATIC ISLET CELL AND OTHER RADIATION-INDUCED TUMORS IN THE RAT. Boschetti, Antonio E.; Maloney, William C. (Holy Ghost Hospital, Cambridge, Mass.). Lab. Invest., 15: 565-75(Mar. 1966).

Observations on 673 rats following total-body x irradiation and orally administered 3-methylcholanthrene confirmed the unique effect of radiation in the induction of pancreatic islet cell tumors. Frequent coexistence of other endocrine and renal cell tumors was especially noteworthy in these irradiated animals. At the age of 3 to 4 months, 161 Wistar and 145 Wistar-Furth rats were exposed to a single total-body dose of 430 rad at a rate 30 to 32 rad/min. Other rats were fed 10 mg of 3-methylcholanthrene in sesame oil by stomach tube for a total dose of 180 mg. Single or multiple tumors were found in 62.7% of Wistar and in 40% of Wistar-Furth rats. Tumor islet cells in most cases were exclusively or predominantly β-cells, whereas in two cases moderately large numbers of α- or δ-cells, or both, were also present. Islet cell tumors developed in 11.4% of non-inbred Wistar rats treated with total-body irradiation and in 11.7% of those treated with irradiation plus 3-methylcholanthrene. In inbred Wistar-Furth rats treated in a similar fashion 3% and 2.2% developed islet cell tumors. Islet cell tumors occurred exclusively in irradiated animals, and the incidence of these tumors in non-inbred Wistar rats was 4.5 times that of the inbred Wistar-Furth strain. The male-to-female ratio in animals with islet cell tumors was 4.8 : 1 and 4 : 1, respectively, for each of the two strains. 3-Methylcholanthrene was devoid of any tumorigenic effect upon the development of either pancreatic islet cell or renal cell tumors. The incidence of islet cell tumors in both strains of rat remained essentially unaltered when total-body radiation was followed by 3-methylcholanthrene. Morphologic and histochemical studies of islet cell tumors afford further support for a dual mechanism of proliferative growth. In addition to mitotic activity of tumor islet cells, the latter may arise de novo from duct epithelium through a process of differentiation termed nesidioblastosis. (BBB)

6678 INFLUENCE OF NEUTRON AND GAMMA WHOLE-BODY IRRADIATION OF LACTATING COWS ON THE CHLORIDE CONTENT OF THE MILK. Demott, B. J.; Cox, Rachel (Univ. of Tennessee, Knoxville). Nature, 212: 190(Oct. 8, 1966).

Chloride determinations were made by titration against silver nitrate of milk samples. Whole body gamma irradiation was given to 4 cows using a cobalt-60 source. Three cows were exposed to fast neutrons for 26 min. Neutron irradiation had an immediate effect on milk composition, but the effect of gamma irradiation was delayed until just before death of the animal. The data indicate that if cows are exposed to lethal doses of gamma radiation in the order of 650 R, as can occur under fallout conditions, the milk will probably be palatable and nearly normal in composition until the animal approaches death. (H.L.W.)

6679 QUANTITATIVE STUDIES ON TISSUE TRANSPLANTATION IMMUNITY. VII. THE NORMAL LYMPHOCYTE TRANSFER REACTION. Brent, L.; Medawar, Peter (National Inst. for Medical Research, London). Proc. Roy. Soc. (London), Ser. B, 165: 281-307(Sept. 13, 1966).

The normal lymphocyte transfer reaction (NLT reaction), a cutaneous inflammatory episode of delayed onset that is aroused when living lymphocytes from one guinea pig are injected into the skin of another, was used to study the immunological performance of lymphoid cells. When the recipient guinea pig is exposed to 600 R whole-body irradiation before transfer, to delay the onset of an immunological counter-attack on the transferred cells, the NLT reaction evolves in three phases spread over about 6 days. These three components may be discerned when the transferred lymphocytes have been presensitized against the tissues of their future recipients, but the pitch of the reaction is much higher throughout and presensitized cells perform as strongly at 24 hrs as normal cells do when they reach the peak of their activity at 5 to 6 days. In general, lymphocyte transfer reactions vary in intensity rather than in tempo: the weak reactions that occur where antigenic disparity is slight, or when relatively few cells are injected, differ from strong reactions, even the very strong reactions caused by presensitized cells, in their general pitch of intensity but not in the relative timing of the various episodes of the response. In terms of the power of a given number of cells to excite an NLT reaction, blood lymphocytes were two to five times more active, and thymocytes ten to twenty times less active, than lymph node cells. Cells from lymph nodes were enlarged greatly by stimulation with human gamma globulin emulsified in Freund's complete adjuvant but were not more effective than normal cells in exciting an NLT reaction. Lymphoid cells from fetal or newborn mesenteric nodes gave bold and clear NLT reactions rising to a peak not lower than that achieved by the same number of adult lymphoid cells. The NLT reaction lent itself very well to a study of inhibitors of the immunological response. Immunosuppressive agents were applied, as appropriate, to the cell donor before transfer, to the lymphoid cells in transit, or to the recipient before, during or after transfer. Immunosuppressive agents did not in general affect the first inflammatory episode; with varying degrees of effectiveness they did, however, eliminate the flare-up. The two most effective agents in this respect (Methotrexate and cyclophosphamide) did not, however, oppose the immunological performance of presensitized cells at concentrations more than sufficient to eliminate the flare-up. It is therefore reasoned that conventional immunosuppressive agents do not affect any distinctively immunological activity of lymphoid cells: they merely prevent the multiplication of the cells activated in the first episode of the NLT reaction, and therefore the transformation of a normal into a sensitized population. Reasons are given for thinking that the antigens that excite the NLT reaction belong to the homograft system and that the reaction as a whole can be construed as a homograft reaction in reverse. (H.G.D.)

6680 RESPONSE TO X-IRRADIATION OF MOUSE EMBRYONIC LUNG CULTURED IN VITRO. RADIATION EFFECT ON THE EPITHELIUM GROWTH RATE. Alescio, T. (Univ., Naples). Exp. Cell Res., 43: 459-73(Sept. 1966). (NYO-3355-7).

The radiation response of mouse embryonic lung rudiments cultured in vitro was studied using as a criterion for a quantitative evaluation of the radiation effect the relative size increment of the epithelial tree as a function of dose. It was shown that the rate of growth of the bronchial tree as a whole appears to be highly radiation-sensitive and that the radiation-induced growth depression effect is dependent on x-ray exposure dose. The dose-effect curves show that an attempt to overcome the radiation growth inhibiting effect is made after 30 hr from irradiation when exposure doses are of 175 R or smaller. A cytological basis for the interpretation of this radiation effect is proposed as a consequence of a selective depletion of the mesenchymal cell population. (auth)

6681 RADIATION-INDUCED MAMMALIAN CELL DEATH: LAPSE-TIME CINEMICROGRAPHIC OBSERVATIONS. Marin, G.; Bender, M. A. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Exp. Cell Res., 43: 413-23(Sept. 1966). (ORNL-P-1807).

In order to further elucidate the process of radiation-induced mammalian cell reproductive death, individual cells of a HeLa S3 line were followed by lapse-time cinemicrography for the first few days following irradiation. Cells receiving doses of 400 or 600 R of hard x rays and unirradiated control cells were studied. No significant delay in the first post irradiation division was seen, although a significant increase was observed in the succeeding interphases. The damage leading to an increase in generation time was not uniformly transmitted among whole progenies, however. No increase in the modal duration of mitosis was seen, but the duration of individual divisions was more variable for irradiated cells. Multipolar mitoses and cell fusions were more common among the progeny of irradiated cells than among those of unirradiated cells. Cell death (as distinct from reproductive death) was observed both in interphase and during mitosis, and was no more frequent in the first postirradiation generation than in subsequent generations. (auth)

6682 TOXIC EFFECT OF X-IRRADIATED MEDIUM ON CHICK EMBRYO CELLS. Levinson, W. (Univ. of California, Berkeley). Exp. Cell Res., 43: 398-413(Sept. 1966).

Irradiated medium can damage chick embryo fibroblasts as evidenced by the inhibition of the spreading and growth of the cells and of their capacity to synthesize Rous sarcoma virus (RSV). The damage is caused by the H_2O_2 generated in the medium by x irradiation. Sodium pyruvate, serum, and conditioned medium can protect these cells from the toxic effects of irradiated medium. (auth)

6683 MODIFICATION OF CORNEAL IMMUNE RESPONSE. I. EFFECTS OF IRRADIATION. Sellyei, Louis F. Jr.; Ellis, Philip P. (Univ. of Colorado, Denver). Amer. J. Ophthalmol., 61: 702-9(Apr. 1966).

This study was undertaken to determine whether corneal immune responses could be modified with β and γ irradiation, and to establish the site of antibody production in primary corneal hypersensitization. Some rabbits received γ irradiation (^{60}Co) to the upper head and eyes alone, 24 hr prior to corneal inoculation, of 4 mg bovine serum albumin (BSA). Other rabbits received γ irradiation to the body with the head and eyes shielded, 24 hr prior to corneal inoculation, of BSA. Additional rabbits received daily topical β irradiation of the eyes for 14 days beginning on the fifth day after corneal inoculation. It was found that γ irradiation to the body alone suppressed the immune response, while irradiation to the eyes alone did not affect the reaction. This indicates that the immunologically competent cells or their precursors originate outside the eye and are mobilized to the eye after receiving antigenic stimulation. (BBB)

6684 EFFECT OF VITAMIN C ADMINISTRATION ON THE TANNING OF SKIN DUE TO ULTRAVIOLET IRRADIATION. Tatai, Khioko; Ogasawara, S.; Takanesawa, Haruko; Tatai, Yashunosuke (Kyohama Women's Univ., Japan). Chiryo, 46: 1315-18(July 1964). (In Japanese).

Healthy female students who lived in the school's dormitory were administered supplements of vitamin C and its effect on the tanning of the surface of thigh skin was studied. A group of 24 healthy students, aged from 19-20 years, was examined. A dose of 1200 mg vitamin C was given per os before every meal to half of the experimental group and 600 mg vitamin C to the other half of the experimental group. A uv lamp was used as the source of irradiation, and an aluminum plate, 2 mm thick with a hole, 25 mm in its center was placed in front of the uv lamp to produce uniform irradiation. The site of irradiation included the dorsal and ventral parts of the skin from both right and left thighs. The degree of tanning was measured by a spectrophotometer. The subjects remained in a natural standing position during the uv irradiation and measurement of the degree of tanning. A decrease of tanning of skin due to uv irradiation was demonstrated in the subjects administered vitamin C. Under the same conditions of uv irradiation, the degree of tanning was greater in unstretched parts of skin. There were individual differences in the response to uv irradiation. (BBB)

6685 EFFECT OF ULTRAVIOLET AND GAMMA RADIATIONS ON THE PROPERTIES OF SKINS AND LEATHER. Guha, N. N.; Ramanathan, N.; Nayudamma, Y. (Central Leather Research Inst., Madras). Leather Sci. (Madras, India), 12: 256-62(July 1965).

The physical and chemical modifications in raw goat skins and variously tanned leathers caused by uv and γ radiations are reported. Doses of 5000 erg/sec cm^2 uv light and 30, 60, and 90 Mrad of ^{60}Co radiation were used. Color changes as well as alteration of tensile strength, elongation at break, and double-hole stitch tear strength were tested. The effects increased with the dose. The general trend of color change is the same after uv and γ irradiation, whereas uv irradiation made it lighter in color. The physical properties deteriorated on exposure to both of these radiations. The degradation in physical properties was more severe with γ radiation and increased progressively with the dose. A comparison made between the effects of uv and γ irradiation suggests that the more deleterious effects of γ radiation can be attributed to greater depth of penetration, and higher energy. The greater resistance of vegetable-tanned leather observed is explained in terms of the effects of these radiations on the chemicals contained in the vegetable tanning materials. (BBB)

6686 FIBROMYXOSARCOMA OF THE ORBIT: RADIATION-INDUCED TUMOR 33 YEARS AFTER TREATMENT OF BILAT-

ERAL OCULAR GLIOMA. Strickland, Paul (Mount Vernon Hospital, Northwood, Eng.). Brit. J. Ophthalmol., 50: 50-3(Jan. 1966).

This case report records an instance of soft-tissue sarcoma of the orbit due, almost certainly, it is averred, to the successful treatment by radium of a retinoblastoma of the retina 33 yr earlier. In 1931, the patient, then 15 months old, was treated with radium for an orbital tumor. Radium was applied to the right eye (twenty 1.5 mg. needles and eight 2.5 mg. needles on a paste mold, as was standard practice at the time). The applicator was removed 5 days later, and the procedure repeated 2 weeks afterwards. Observation during the next three months showed no tumor regression so that further radium application was carried out; 157 mg was used and left in situ for 88 hr. Treatment was discontinued and 15 yr later the patient was apparently well. In the autumn of 1963 a lump developed on the same eye. In September, 1964, 33 years after the original radium treatment to the right eye, a mass measuring 10 × 7 cm and raised 7 cm above the skin was seen totally replacing the right orbit, filling the temporal fossa, and replacing much of the right side of the face. A diagnosis of radiation-induced soft-tissue sarcoma was made; recurrent retinoblastoma was thought to be only remotely possible. The patient died 12 days later. Sections of the tumor showed a pleomorphic spindle-cell sarcoma with much myxomatous degeneration, the features of a fibromyxosarcoma arising in the soft tissues immediately behind the eye. Sufficient data were found from the original case notes to determine that the retina received a dose of at least 9250 R. Assuming that the center of the retina was 1.8 cm. deep to the anterior surface of the globe, tissues 5 and 10 mm deep to the retina would have received doses of 6900 and 6100 R respectively. (BBB)

6687 EXPERIMENTAL STUDIES ON THE EFFECTS OF INTERNAL EXPOSURE OF ^{137}Cs ON THE MALE REPRODUCTIVE ORGAN. II. THE DISTRIBUTION OF THE ^{137}Cs IN THE BODY OF MICE AND HISTOLOGICAL CHANGES OF TESTIS FROM ITS EXPOSURE. Tamura, Toshiyuki (Okayama Univ. Medical School, Japan). Nippon Eiseigaku Zasshi, 20: 320-8(Dec. 1965). (In Japanese).

The distribution of ^{137}Cs in various tissues of mice and changes in the germinal cells of seminiferous tubules following ^{137}Cs administration were examined in dd strain mice. The 120 male mice were given 8 μC of ^{137}Cs per g of body weight (first group) or 4 μC/g of body weight (second group) intraperitoneally. Animals were sacrificed at 1, 3, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 days after the injection. The right testis, kidney, spleen, liver, heart, and lung were measured for radioactivity. Histological preparations were made from the left testis. In the testis, radioactivity reached a maximum the 3rd day after injection, and then decreased gradually up to 100 days. Activity in testes was always higher than in any other organs except 24 hr after the injection. The order of the radioactivity in various organs was: heart > kidney > liver > spleen > lung. Degeneration and a decrease in number of spermatogonia were found as early as 10 days after injection. By 30 days after the treatment, injury to germ cells was maximal. Recovery was observed from 30 days onward and reached 90% by 70 days after the injection. Based on histological changes, the first group showed more marked injurious changes as compared with the second group which received only half as much ^{137}Cs. (BBB)

6688 DETECTION OF MINUTE DOSES OF IONIZING RADIATION. Feder, B. H.; Garcia, J.; Koelling, R. A.; Buchwald, N. A. (Veterans Administration Hospital, Long Beach, Calif. Univ. of California, Los Angeles. California State Coll., Long Beach). Acta Radiol. Therapy, Phys., Biol., 5: 101-4(1966).

The physiologic radiosensitivity of the mammalian central nervous system can be shown by several special techniques. One of these is the detection phenomenon demonstrated by the previously conditioned rat. In this experiment response occurred promptly to an exposure of as little as 20 mR x radiation. (auth)

6689 EXPERIMENTAL CONTRIBUTION TO THE PROBLEM OF TUMOR PREIRRADIATION. Lorenz, Werner (Univ., Mainz). Krebsforsch. Krebsbekaempf., 5: 201-6(1964). (In German).

The survival time of mice injected intravenously with irradiated Ehrlich ascites tumor cells was longer than that of mice intraperitoneally injected with the cells. The survival time of the animals differed by a factor of ~2. About 90% of the intravenously injected animals died within 60 days, mostly with metastases in the thorax and axillary regions. The tumor cells administered were obtained from animals that had received whole-body preirradiation with 190-kv x ray. Over a 60-day observation interval after administration of the tumor cells from the irradiated animals the % survival in the host animals that were injected intraperitoneally was 40, 19, 69, and 100% when the tumor irradiation was 8 × 125 R, 4 × 250 R, 4 × 500 R, and 4 × 1250 R, respectively. In the animals intravenously injected with tumor cells irradiated at these doses, the survival time was 87, 98, 100, and 100%, respectively. (BBB)

6690 LIFESPANS OF MICE EXPOSED TO EMBRYONIC X IRRADIATION. Nash, Donald J.; Gowen, John W. (Colorado State Univ., Fort Collins). Rec. Genet. Soc. Amer., 48: 903-4(1963).

Effects of irradiation on lifespan were examined in mice. Three inbred strains BALB/Gw, K, and S and their possible hybrids, nine types, were exposed in utero to single whole-body doses of x-ray. Doses of 0, 20, 80, 160, and 320 R at 6.5, 10.5, 14.5, and 17.5 days gestation, were administered. The experiment was factorial in design, with five x-ray doses, five embryo ages plus controls, two sexes, and nine genetic types. In some groups, no progeny survived the embryo treatments (6.5 day-320 R, 10.5 day-160 and 320 R). At two and a half months of age two males and two females of each genotype and treatment were mated to unrelated mates and examined for their lifetime productivities and lifespans. The most pronounced effect came not from irradiation per se but from whether or not the mate whose lifespan was determined was male or female: 565 days for treated males, 356 days for treated females. This is in agreement with other studies in which rapid reproductivities exerted severe depressing effects on lifespans of the female sex. Differences in genotypes had a highly significant effect on lifespan. Lifespan decreased significantly with increasing irradiation exposure. If the mouse survived to 75 days, the time of exposure in utero had little effect on survival. (BBB)

6691 RADIOGENIC FRACTURES OF THE FEMUR NECK. Herzog, K. H.; Bartel, M. (Friedrich-Schiller Univ., Jena, Ger.). Monatsschr. Unfallheilk., 67: 453-64(Nov. 1964). (In German).

The problems associated with the etiology, diagnosis, treatment, and prognosis of 17 radiogenically induced fractures of the neck of the femur observed in 14 patients previously treated for gynecological tumors are presented and discussed. The time interval between irradiation and appearance of the spontaneous fracture ranged from 9 months to 4 yr. The average time was 1.6 yr, and the average patient age was 67 yr. The total doses of irradiation given differed considerably from patient to patient, and some were also irradiated with Ra implants. In the patients given γ irradiation alone the doses ranged from 7100 R to 18,150 R. When combined x irradiation and Ra treatment was given the irradiation dose ranged from 2630 R to 12700 R, and the Ra implant dose amounted to from 4000 to 6000 mg-hr. The fractures were nailed or bolted, and the treatment results obtained were the same as those obtained by these treatments for traumatic fractures. (51 references) (TSS)

6692 STUDIES OF THE RADIATION EFFECTS ON CELLS. V. ELECTRON MICROSCOPE STUDIES ON THE EARLY EFFECTS ON TUMOR CELLS AFTER IRRADIATION. Nagase, Tetsuya (Tokushima Univ., Japan). Shikoku Igaku Zasshi, 21: 149-54(Feb. 1965). (In Japanese).

Electron microscopic studies were conducted on two types of tumor cells at early stages postirradiation. MTK sarcoma III ascites tumor cells were transplanted in Wistar rats and then irradiated with 500- or 1000-R doses of 200-kv x rays. HeLa cells cultured in vitro were irradiated with x-ray doses up to 2000 R. Both types of cells were examined 5 min to one hr after irradiation and after staining sections with uranyl acetate. Structural changes in the organelles of the cells were as follows. Nuclear chromatin initially showed a decrease in electron density, then underwent chromatolysis. The endoplasmic reticulum showed marked changes, with loss of its granular components (ribonucleoprotein particles). The mitochondria became swollen and their electron density decreased. Their cristae became fragmented and irregular in form. These injurious alterations in cells became most marked 15 to 30 min after exposure, especially at the higher doses, and after one hr, signs of recovery of the normal substructure of the cells were discernible. (BBB)

6693 X-RAY DOSIMETRY IN THE BRAIN OF RATS AND GUINEA PIGS. Roessner, W.; Tempel, K. (Tierarztliche Fakultaet, Munich). Zentralbl. Veterinaermed., Reihe A, 13: 278-82 (Mar. 1966). (In German).

The authors describe experimental animal holders adapted for measurement of absorption of ionizing radiation by the brain of the rat and guinea pig. Various methods of immobilizing the animals during irradiation and the use of the measurement system are discussed and illustrated. Irradiation doses measured are tabulated for the animals in the regions of the scalp, cranial roof, and brain. The focus-to-object distance used was 3.5 cm, and the current used ranged from 8 to 36 ma. The irradiation exposure varied in direct proportion to the energy of the x radiation used, which ranged from 50 to 60 kr. The bone absorbed more than 64% of the total radiation absorbed by the exposed head, the brain absorbed ~32% and the skin absorbed ~4% of the total. Of the total measured incident radiation, more than 26% was absorbed by the bone and 13% was absorbed by the brain. Only 1.5% was absorbed by the skin. (BBB)

6694 EXPERIMENTAL STUDIES ON SYNCARCINOGENESIS. Schmaehl, Dietrich (Univ., Bonn). Krebsforsch. Krebsbekaempf., 5: 127-30(1964). (In German).

Rats were given 320 R of whole-body x-irradiation 24 hr before administration of diethylnitrosamine. The irradiation was given at a rate of 20 R/min, and the chemical carcinogen was given at a rate of 3 mg/kg/day. In agreement with earlier findings all of the animals developed hepatomas within 225 to 230 days, after the average total dose of the chemical amounted to 674 ± 45 mg/kg. There was no additive effect due to irradiation. Previous studies suggested that whole-body irradiation of rats does not produce hepatomas, but instead may induce a high frequency of incidence of mammary tumors. This may explain the lack of effect of irradiation to enhance production of hepatomas by diethylnitrosamine. (BBB)

6695 NEUROLOGIC MANIFESTATIONS OF INJURY BY IONIZING RADIATION. Aita, John A. (Univ. of Nebraska Coll. of Medicine, Omaha). Nebr. State Med. J., 50: 567-70(Nov. 1965).

The biological effects of radiation exposure of the nervous system are reviewed. In the adult, peripheral nerves are more resistant to radiation injury than spinal cord; spinal cord appears more resistant than cerebrum. Experiments on animals suggest that high intensity irradiation at acute doses may cause rapid death from effects on medullary centers. Doses may be adjusted sufficiently high to cause instant death. In humans, as 1500 rad or 2000 R (acute doses, general exposure) are approached and exceeded, cerebral symptoms appear within hours, and death often within a few days. Over 5000 R exposure may be fatal within hours (even when limited to the head). These appear to be primary cerebral (medullary) deaths. Neuronal damage, cerebral edema, and diffuse cerebral radiovasculitis were reported. However, secondary cerebral effects may occur from shock, intense gastrointestinal damage (fluid and electrolyte loss) and blood cellular derangement should the individual survive sufficiently long to allow these to appear. Chronic radiation effects on brain are commonly the result of radiation therapy to or near the brain. Hazards of brain radiotherapy are discussed. (TSS)

6696 EFFECTS OF INJECTED NOREPINEPHRINE AND SYMPATHETIC NERVE STIMULATION IN HYPOTHYROID AND HYPERTHYROID DOGS. Margolius, Harry S.; Gaffney, Thomas E. (Univ. of Cincinnati). J. Pharmacol. Exp. Therap., 149: 329-35 (Sept. 1965).

The effect of large doses (1 mCi/kg) of ^{131}I and thyroid hormone on arterial pressor and chronotropic response to norepinephrine was studied. The intraperitoneal administration of 1 mCi of ^{131}I per kg produced a clear decrease in awake heart rate, motor activity, and uptake of ^{131}I in the neck and an increase in weight in each dog. The skin of each of these animals gradually became tight, and at the time of each experiment, 5 months after the ^{131}I injection, the subcutaneous fat depots were greatly increased over those seen in control dogs. The anesthetized heart rate, mean arterial pressure, and arterial pulse pressure of these hypothyroid dogs were the same as those reported for the control dogs. No thyroid tissue could be found at autopsy in any of these dogs. Serum protein-bound iodine levels averaged 3.6 $\mu g\%$ and butanol-extractable iodine levels averaged 2.0 $\mu g\%$. In the hypothyroid dogs the pressor effect of injected norepinephrine was slightly attenuated when compared to the responses observed in the combined control groups. In the same experiments the chronotropic effect of injected norepinephrine and the chronotropic and pressor effects of sympathetic nerve stimulation were the same in hypothyroid and control dogs. These data in hyperthyroid, hypothyroid, separate and combined groups of euthyroid dogs, when viewed collectively, do not demonstrate a clear or consistent alteration in the cardiovascular effects of injected or endogenously released norepinephrine. (BBB)

6697 NOTE ON EFFECTS AND INFLUENCE OF RADIOACTIVE RAINWATER UPON LIVER AND SPLEEN OF MICE DURING PREGNANCY. Sakashita, Sakae (Mie Prefectural Univ., Tsu, Japan). Mie Med. J., 14: 213-19(Jan. 1965).

Mice were injected subcutaneously on the 8th day of pregnancy with evaporated rainwater containing various levels or radioactivity (32 to 1150 $\mu\mu C$). The rainwater was collected in July 1958 during a typhoon in Japan which carried fallout from nuclear weapons tests being conducted in the South Pacific. Both liver and spleen of maternal mice showed histological changes following injection of radioactive rainwater; those in the liver were less marked. The results resembled those seen after injection of ^{32}P. A major finding was the disordered arrangement of the hepatic cell trabeculae, brought about by atrophy of the cells and pyknosis of nuclei. Also seen were changes in nuclear staining. In the control group, with either hematoxylin-eosin or azan stain, dark nuclei were more prevalent than light ones, while in the experimental groups they were less frequently noted. This was most evident in the 460-$\mu\mu C$ injected group, and progressively less so in the 550 and 1150-$\mu\mu C$ groups. The spleen showed changes in the experimental groups, especially after injection of 460 $\mu\mu C$. In the control group the lymph nodes were large and distinct, whereas in the experimental groups, they became small and obscure, with many erythrocytes being present in the node. The lymph nodes in the 550-$\mu\mu C$-injected group were difficult to detect, and composed almost entirely of small lymphocytes. This suggests decrease in lymph node function, and the increased number of erythrocytes supports this concept of lowered function, as the spleen is known to destroy excessive erythrocytes. A decrease in reticular cells was also noted. Megakaryocytes increased, as a rule, in the experimental groups. (BBB)

6698 CYTOVOLUMETRIC OBSERVATIONS ON EHRLICH ADENOCARCINOMA SUBJECTED TO X IRRADIATION. I. MODIFICATIONS INDUCED IN CELLS OF THE 1st TYPE. Paolini, F. A.; Rodolico, R.; Bandirali, G. R. (Univ., Pavia, Italy). Boll. Soc. Ital. Biol. Sper., 42: 343-6(Apr. 15, 1966). (In Italian).

Forty Swiss strain mice were injected with a 0.2-ml suspension of Ehrlich adenocarcinoma ascites cells and x-irradiated 7 to 12 days later. The dose varied from 200 to 3000 R and was delivered at one time to the muscle site of the growing solid tumor. Cytovolumetric studies were made separately on the three types of cells as classified by Homann (Z. Krebsforsch., 58: 511(1951-2)), changes in type 1 cells being described in this report. Irradiation with 200 R produced no change in the volume of the nucleolus, nucleus, or cytoplasm. Irradiation doses of 600 R only slightly increased nucleolar volume, but appreciably enlarged the nuclear and cytoplasmic volume. No further increase in nuclear volume was noted with a 1000 R dose, the volume being 32% above the control value. Cytoplasmic volume was increased 31%. Further increases in nuclear and cytoplasmic volume occurred after 3000 R irradiation. (BBB)

6699 CYTOVOLUMETRIC OBSERVATIONS ON EHRLICH ADENOCARCINOMA SUBJECTED TO X IRRADIATION. II. MODIFICATIONS INDUCED IN CELLS OF THE 2nd TYPE. Paolini, F. A.; Rodolico, R.; Bandirali, G. R. (Univ., Pavia, Italy). Boll. Soc. Ital. Biol. Sper., 42: 347-50(Apr. 15, 1966). (In Italian).

Cytovolumetric changes were examined in cells of the 2nd type, which represent the majority of those in Ehrlich tumors. The cells can be differentiated from cells of the 1st and 3rd types on the basis of staining reactions and morphology. Tumors were irradiated with 600 to 3000 R x-ray doses 7 to 12 days after injection of a suspension of Ehrlich adenocarcinoma cells in the muscle of Swiss mice. Doses of 200 R did not induce significant changes in the volume of the nucleolus, nucleus, or cytoplasm. After 600 R only the cytoplasmic volume was appreciably enlarged (32% above normal), unlike the results in type 1 cells, which underwent nuclear enlargement also, after 600 R. The 1000-R dose resulted in an enlargement of the nucleolus. Nuclear enlargement reached 60% above normal after 2000 R, and was not further changed by the 3000-R dose. (BBB)

6700 CYTOVOLUMETRIC OBSERVATIONS ON EHRLICH ADENOCARCINOMA SUBJECTED TO X IRRADIATION. III. MODIFICATIONS INDUCED IN CELLS OF THE 3rd TYPE. Paolini, F. A.; Rodolico, R.; Bandirali, G. R. (Univ., Pavia, Italy). Boll. Soc. Ital. Biol. Sper., 42: 351-4(Apr. 15, 1966). (In Italian).

Cells of the 3rd type, giant polynuclear cells, found in Ehrlich tumors were examined cytometrically. The Ehrlich adenocarcinoma cells had been inoculated in the muscle of Swiss mice and x-irradiated 7 to 12 days later. No significant change in nucleolar, nuclear, or cytoplasmic volume occurred after 200 R irradiation. After 600 R the nucleolus enlarged 28%, the nucleus 22%, and the cytoplasm 27%. Irradiation with 1000 R heightened the distribution peaks of volume measurements without further augmenting the values. The 3000 R dose did not significantly elevate volumes but by this level the cytoplasmic volume had reached 52% above normal. In general, the type 3 cells underwent similar postirradiation volume changes as were seen in type 1 and 2 Ehrlich tumor cells. (BBB)

6701 TUMOR PRODUCTION BY WHOLE-BODY X IRRADIATION OF RATS OF VARIOUS AGES. Stutz, Ernst (Univ., Freiburg i. B.). Krebsforsch. Krebsbekaempf., 5: 151-5(1964). (In German).

Rats were irradiated with 270 R of whole-body x-irradiation at ages that ranged from 5 days before birth to 121 days after birth. The ages selected for irradiation corresponded generally to human periods of fetal growth, infancy, youth, and adulthood. Almost all of the rats irradiated as adults survived the irradiation. The younger the age group the greater was the percentage that died. Over 44% of the irradiated fetuses died, 9.1% of the newborn died, and 8% of the young animals died after irradiation. The fetal group developed numerous malformations, including cerebral hypoplasia, hydrocephalus, optic hypobulbia, and hypoplasia of the uterus or

testis. Growth was inhibited frequently. The survival time of the fetally irradiated animals was not less than that of the animals irradiated at later times. Tumors were observed in the animals. The frequency of incidence ranged from 26.7 to 30.2% in the irradiated male animals, and from 36.3 to almost 90% in the irradiated females. Multiple tumors frequently were found, but the central nervous system, the liver parenchyma, and thyroid were not affected. Leukemias did not appear. Most of the tumors in the females involved the genital organs. (BBB)

6702 TRANSPHENOIDAL ^{90}Y PITUITARY ABLATION. RADIATION DAMAGE TO THE INTERNAL CAROTID ARTERIES. Kaufman, B.; Lapham, L. W.; Shealy, C. N.; Pearson, O. H. (University Hospitals, Cleveland). Acta Radiol. Therapy, Phys., Biol., 5: 17-25(1966).

Histologic features of radiation damage to the cavernous portions of the internal carotid arteries occurring in 6 cases treated with intrasellar ^{90}Y for total pituitary ablation are described. Radiation damage varied from minimal injury to necrosis. The structures most severely affected were media and intima. Anatomic relationships of the cavernous portion of the internal carotid artery and the pituitary gland are discussed as they pertain to intrasellar ^{90}Y dosimetry. (auth)

6703 TIME-DOSE CONSIDERATIONS IN RADIATION MYELOPATHY. Atkins, Harold L.; Tretter, Patricia (Brookhaven National Lab., Upton, N. Y. Columbia Univ., New York). Acta Radiol. Therapy, Phys., Biol., 5: 79-94(1966).

Data on 14 cases of radiation myelopathy are presented. Almost all were treated with an unconventional fractionation technique. Comparison is made with cases described in the literature and with tolerance levels previously suggested. In the use of unconventional fractionation where fewer but larger radiation doses are administered, the spinal cord tolerance is a limiting factor. It is imperative to protect the cord from the direct beam or to restrict the total dose which the cord may receive to safe levels. (auth)

6704 BLOCKAGE OF PUPILLODILATION WITH CYCLOTRON-ACCELERATED ALPHA PARTICLES. Gaffey, C. T. (Univ. of California, Berkeley). Acta Radiol. Therapy, Phys., Biol., 5: 105-17(1966).

Contact with the pupillodilation center (nucleus perifornicalis of the hypothalamus) was made by insertion of bipolar electrodes through burr holes in the skull of cats. Electrical stimulation of the pupillodilation center was made through the head socket of alert cats and the center of the cat's brain was irradiated by a cross-fire technique using accelerated α particles. Since the implanted electrode was in the center of the irradiated volume the time-course for the blockage of pupillodilation could be studied as a function of the delivered dose of alpha particles. It was found that the action of electrical stimulation on the pupillodilation center could be inhibited immediately and irreversibly by 100,000 rad. Below 8,000 rad there was no detectable effect. With doses less than 32,000 rad the threshold voltage to produce pupillodilation followed a biphasic pattern. (auth)

6705 EFFECTS OF ROENTGEN RADIATION ON GLYCOGEN METABOLISM OF THE RAT BRAIN. Miquel, Jaime; Lundgren, Paul R.; Jenkins, Jane O. (Ames Research Center, Moffett Field, Calif.). Acta Radiol. Therapy, Phys., Biol., 5: 123-32(1966).

The effects of roentgen radiation on dose and time relationships of glycogen accumulation in rat brain were investigated. Glycogen increase was noticed at the completion of exposure to 3,000 R. The glycogen level was maximal at the 12 to 30 hour interval and then it returned to near normal values. Moreover, the glycogen was observed to increase linearly in relation to the radiation dose from 0 to approximately 6,500 R. Further increases in dose resulted only in a slight rise in the glycogen level above the value obtained at 6,500 R. Roentgen irradiation of the rat head with 3,000 R in environments of 99.5% O_2 at 1 and 4 atm did not reveal any oxygen effect when cerebral glycogen accumulation was used as a parameter. Further, exposure of O_2 per se did not result in glycogen accumulation at the 24 hour interval. (auth)

6706 OXYGEN EFFECT AND SELECTIVITY OF RADIOLESIONS IN THE MAMMALIAN NEURAXIS. Zeman, Wolfgang (Indiana University Medical Center, Indianapolis. Brookhaven National Lab., Upton, N. Y.). Acta Radiol. Therapy, Phys., Biol., 5: 204-16(1966).

Selective radionecrosis of the neuraxis occurs as regional and cellular selectivity. The assumption that the oxygen effect might account for regional selectivity of radiation damage was experimentally tested on the murine spinal cord. With a threefold increase in the local oxygen tension relative sensitivity increased by a factor of about 1.15. These data indicate that regional selectivity of delayed radionecrosis of the murine spinal cord can only in part be related to the oxygen effect. (auth)

6707 ACUTE BLEEDING EFFECT ON THE GASTRIC SECRETION IN IRRADIATED ANIMALS. Mikaelyan, M. G. (Erevan Inst. of X-Ray Radiology and Oncology). Zh. Eksp. Klin. Med., 6: No. 4, 27-31(1966). (In Russian).

Mongrel dogs, aged 2 to 5 years and weighing 14 to 23 kg were x-irradiated with a single total body dose of 100 R. Acute bleeding 20 to 25 min. after irradiation caused a strong inhibition of gastric secretion which lasted until the animals perished. In non-irradiated control animals, acute bleeding caused only temporary inhibition of gastric acidity and fermentation functions. (W.E.B.)

6708 EFFECTS OF IONIZING RADIATIONS ON MAMMALIAN DEVELOPMENT. Hicks, Samuel P.; D'Amato, Constance J. (Univ. of Michigan, Ann Arbor). pp 195-250 of Advances in Teratology. Woollam, D. H. M. (ed.). London, Logos Press, 1966. (TID-21536; COO-1201-6).

A review (130 references) which considers the following topics: interactions between radiation and biological systems, malformative patterns caused by radiation, radiosensitivity at various stages of the mitotic cycle and cellular differentiation, histogenetic and cytologic sequences in malformation, variability in response to radiation, effects of low levels of radiation, somatic cell mutations, chronic radiation and multiple exposures, effects of radioactive isotopes in the body, and effects of radiation on the development of function and behavior is presented. Developmental malformations initiated by whole-body irradiation, such as single exposures of pregnant or infant animals to external or x rays, are determined by several factors, particularly the stage of development, amount and kind of radiation, and kind of animal. Internally administered radioisotopes may show different patterns when they concentrate in various organs and act over a period of time. A usual range of exposure to x rays in rodent work has been between 100 and 400 R, because a reproducible spectrum of malformations can be secured by irradiating the pregnant or infant animal between about the 7th day of intrauterine life and a week or more after birth. As the exposure is reduced below this range, less and less gross malformations are evident, but even 10 R has a widespread, although subtle, effect on young growing cells. As 300 R is exceeded, malformative growth is increasingly severe and destruction of some embryos and fetuses occurs. The principal effect first seen within hours after irradiation is selective destruction of certain classes of primitive embryonal cells in various sites in the embryo. The nature of these cells and why they may be radiosensitive at different stages are discussed. Malformation patterns in rats and mice after irradiation are described in detail. Also considered are some aspects of the morphologic development of the nervous system and behavioral or neurophysiological changes that paralleled them which have been studied in irradiated pigs, dogs, cats, or rabbits. The authors' experiments on radioinduced effects in the developing nervous system of rodents are extensively reported and illustrated. (BBB)

Radiation Effects on Plants

Refer also to abstracts 6427 and 6480.

6709 (ORO-3092-10) INDUCED MUTATIONS AT SPECIFIC LOCI IN HIGHER PLANTS. III. MUTATION RESPONSE AND SPECTRUM OF MUTATIONS AT THE Vb LOCUS IN AVENA BYZANTINA C. KOCH. Wallace, A. T.; Singh, R. M.; Browning, R. M. (Florida Agricultural Experiment Station, Gainesville). June 1966. Contract AT(40-1)-3092. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In Avena byzantina the Vb locus, or closely linked multiple loci, control the reactions to two pathogens, Helminthosporium victoriae, a faculative parasite, and Puccinia coronata, an obligate parasite. Several hundred mutants of Avena byzantina, resistant to H. victoriae toxin, were induced by exposure of seeds to γ radiation or treatment with two mutagenic chemicals, diethyl sulfate and ethylenimine, and isolated by a mass screening technique. Data are presented on the mutation rates obtained with the various seed treatments used. Preliminary results are reported from a genetic analysis of the mutations. Evidence indicates that the Vb locus evolved in response to P. coronata and not to H. victoriae. (C.H.)

6710 (RM-4904-TAB) EFFECTS OF ACUTE DOSES OF γ-RADIATION ON PINE TREES. OKunewick, J. P. (RAND Corp., Santa Monica, Calif.). Oct. 1966. Contract AT(04-3)-414. 35p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The sensitivity of pine trees to γ- and x-irradiation is reviewed for the purpose of establishing whether or not the genus Pinus would be seriously affected by exposure to doses of 2000 R or less. On the basis of acute-exposure data, it was found that pine trees are approximately as sensitive as is man. Experimentally determined values for LD_{100} for four different pine species range from

1000 to 1800 R. Doses that produce severe inhibition of growth are reported to range from 300 to 715 R. Predictions of LD_{100} values, based on nuclear volume techniques, give even lower values for the LD_{100} of various pine species, ranging from 301 to 1056 R. Severe growth inhibition is similarly predicted for various species at doses between 184 and 615 R. Recovery patterns for trees severely damaged by irradiation are also considered. Following a single acute exposure, it was found that the radiation-damaged tree could recover in a manner similar to trees injured by causes other than irradiation, the main aftereffect of sublethal damage to the irradiated tree apparently being the loss of approximately one year's growth. Data concerning the effects of radiation on the genetic material of these species were not sufficient to allow direct prediction of the effects of radiation on reproductive capacity. Data available for the effects of radiation on the fully formed seed are reviewed. Pine seeds, in general, seem to be more radioresistant than trees. Doses that would be an LD_{100} for seedlings or mature trees are only LD_{50} for seeds. Seed-moisture levels, the time between irradiation and planting, and the metabolic state of the seed at irradiation all seem to interact to alter the sensitivity. The values of the LD_{50} for seeds vary between 200 and 20,000 R, depending on species and conditions, with the median value between 1000 and 2000 R. The data do indicate, however, that postirradiation treatment of pine seeds by moist stratification may decrease the percentage of irradiated seeds that would not otherwise germinate. Therefore, a possibility of reversing the effects of radiation on pine seeds by postirradiation treatment does exist. In relation to a hypothetical nuclear attack based on 147 strategic targets subjected to 15-MT bombs, it is probable that over 8 percent of the total land mass of the United States might receive enough irradiation to kill all of the pines in the affected areas. Approximately 19 percent would receive enough to kill the majority of the pines in the affected areas, and about 45 percent would receive enough exposure to seriously affect the growth of the trees of the area. The need for additional studies relating to chronic and fallout irradiation as well as to the ecological problems of recovery and succession in postattack management of wild lands is pointed out. (H.G.D.)

6711 (UCD-34P112-28) RADIATION BIOCHEMISTRY OF FRUIT. Annual Report, 1966. Romani, Roger J. (California Univ., Davis. Dept. of Pomology). Aug. 15, 1966. Contract AT(11-1)-34. 27p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Progress is reported on studies on the biochemical effects of ionizing radiation on fruit tissues, with emphasis on intercellular particles. Data are reviewed from published results of studies on the effects of a 700 krad dose of ionizing radiation on respiration in pear tissues; the effects of doses of 250 to 1,000 krad radiation on the yield of mitochondria from fruit cells during various stages of ripening; the effects of radiation on metabolism in mitochondria in fruit tissues; and the isolation and physical characterization of ribosomes from apple and pear fruit. (C.H.)

6712 HEADING OF PLANTS GROWN FROM X-IRRADIATED VERNALIZED SEED OF WINTER CROP WHEAT. Avakyan, D. O.; Babayan, V. O. (Lab. of Radiation Genetics, Academy of Sciences, Armenian SSR). Biol. Zh. Arm., 19: No. 6, 18-22(June 1966). (In Russian).

The x irradiation of incompletely vernalized seed stimulates to a significant degree the earing of winter wheat. The seeds are most sensitive to x radiation at the beginning and the end of vernalization. The greatest effect was observed during irradiation of seeds before vernalization. X radiation of incompletely vernalized seed stimulates the physical-chemical processes that protect during vernalization. (tr-auth)

6713 APPEARANCE OF VALUABLE FORMS IN OATS DERIVING FROM SEEDS IRRADIATED WITH THERMAL NEUTRONS. Grinvald, Clara. An. Inst. Cercet. Pentru Cereale Plante Teh-Fundulea, Ser. C, 31: 115-29(1965). (In Rumanian).

Between 1960 and 1963 the effect of thermal neutron irradiation in producing variation in oats was studied as well as the detection and isolation of valuable mutants which might be used as base material for new varieties. Two winter oat populations of hybrid origin were used in F_6: PH 310 (Cenad 578 × Trifurcatum) × Cenad 396 and PH 498 (Cenad 396 × Mittelfrühe). The dry seeds were irradiated at the Brookhaven National Institute (U.S.A.) during three and four hours with integral doses of 7.56×10^{12} and 1.03×10^{13} thermal neutrons. A great variability was found in the length of the growth period, in resistance to smut and in yield. Thus in M_2, out of 2,400 studied progeny, 4.9 percent were by 1–12 days earlier than the initial non-irradiated forms, 50.1 percent were by 1–7 days later and 45.2 percent had the same growth period. In M_3, out of 357 lines, 51.4 percent proved inferior to the controls, yielding 5–45 percent less. But in M_3–M_4 lines yielding 4–26 percent more than the controls were isolated. In 1962—when there was a strong smut contamination—the resistance of the irradiated material to this disease was established in natural conditons. Some lines (24.4 percent) practically immune to smut or just slightly damaged were isolated. By plant breeding, a small number of early lines with a large yield and good resistance to disease was obtained. (auth)

6714 INDUCTION OF MUTATIONS AND PLANT BREEDING. Singleton, W. Ralph (Univ. of Virginia, Charlottesville). Europe. Ass. Res. Plant Breed., 3rd Congr., Paris, 143-55(1962).

Use of ionizing radiations in producing mutants of economic value in agriculture is considered, both in general terms and with reference to mutants in corn produced in a ^{60}Co γ radiation field. Dominant stocks of corn were irradiated and pollen placed on recessive stocks grown outside the radiation area. Genes studied included R (colored aleurone), Su (starchy kernel), Y (yellow endosperm) and Pr (purple rather than red aleurone). Since corn plants at different stages of development showed a wide range in susceptibility to radiation, plants were placed in the irradiation area for short periods of moderately intense radiation. Postmeiotic changes are largely, perhaps all, chromosomal events. The developing pollen grains following meiosis showed the greatest susceptibility to radiation. However, more than 90% of these changes were multiple losses, involving more than one gene in the chromosome under test, definitely showing a chromosomal event. Fewer changes were induced in cells of plants irradiated before the reduction division (meiosis) had been reached. It seems likely that resistance to a particular disease may be induced in an inbred line without introducing any extraneous germ plasm from other lines. Much more information is needed on the use of radiation to ensure beneficial mutations. (BBB)

6715 EFFECT OF RADIOACTIVE COBALT ON CHARACTERS OF SOME WHEAT VARIETIES. Mohamed, Hosni A.; Omar, A. M.; Barahamtoushy, Mosa El (Bahtim Experimental Station, Cairo). Wheat Inform. Serv. (Jap.), No. 19, 16-17(1965).

Dry seeds of the varieties Tosson, Giza 144, and Giza 150 (Triticum vulgare), Baladi Bahtim (T. durum), Baladi 116 (T. pyramidale), and Einkorn (T. monococcum) were exposed to ^{60}Co at doses of 5000, 10,000, 20,000 and 30,000 R. Treated seeds and untreated seeds were planted under greenhouse and field conditions. Data are presented on seed germination percentage, seedling growth, seedling survival, adult plant characteristics, grain yield, and mutation induction after exposure of seeds to various radiation doses. (C.H.)

6716 MUTATION BREEDING IN VEGETATIVELY PROPAGATED CROPS. Broertjes, C. (Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen, Netherlands). Mededel. Directeur Tuinbouw, 26: 736-43(Dec. 1963). (In Dutch).

The possibilities of mutation breeding in vegetatively propagated crops are discussed. Such possibilities depend mainly on the genetic constitution of the crop. The physiological and developmental stage during which irradiation is carried out is important; a good selection method is decisive for final success. For chrysanthemums, the best treatment was found to be irradiation of young plants; the main stem was cut back and the new shoots replanted; the cycle was repeated several times with exposure to 1000 to 2000 R. Roses were irradiated with up to 4000 (diploid) or 8000 (tetraploid) R, then allowed to grow out normally; mutant blooms, and two sectorial chimeras, and complete mutant blooms from Rosa baccara are illustrated. The most appropriate dose for African violets was found to be 3000 R, after which 25% of the plants had mutants. Possibilities in a number of other crops are suggested. (BBB)

6717 SOME EFFECTS OF IONIZING RADIATION ON THE METABOLISM AND GROWTH OF SUGAR BEETS. Stout, Myron (Dept. of Agriculture, Logan, Utah); Spikes, John D. Contract AT(11-1)-875. J. Amer. Soc. Sugar Beet Technol., 13: 333-40 (Jan. 1965).

Effects of radiation on beet roots were studied by cutting roots of large beet roots in half, exposing one-half to gamma radiation, and measuring respiratory rates by the Warburg technique. The rate was considerably increased following radiation. This would indicate that gamma radiation would not be a useful technique for decreasing respiratory sugar losses in stored sugar beets. Effects of gamma radiation on leaf respiration were studied by cutting disks from sugar beet leaves and determining respiratory rates following exposure to a cobalt-60 source. For several days there was an increase in rate, following which the rate decreased with time. Effects of radiation on chlorophyll and on photosynthesis are discussed. Sugar beet seeds were x irradiated with various doses. Germination was delayed and the percentage of seeds germinating was decreased. When the effects of gamma radiation on growth were tested, it was found that growth was inhibited in proportion to the radiation dose. (H.L.W.)

6718 BIOPHYSICAL ASPECTS OF THE EFFECTS OF NEUTRONS ON LIVING CELLS. Barendsen, G. W. Atoomenergie Haar Toepass., 8: 174-9(Aug. 1966). (In Dutch).

The difference between the relative biological effectiveness of neutron irradiation and that of x and γ radiation are discussed. The energy dissipation of neutrons in biological materials, the relative biological efficiency of fast neutrons, the possibilities for the restoration of radiation damage, and the influence of the cellular milieu on the radiation effects are discussed. (tr-auth)

6719 CHANGE IN THE POLYPHENOL OXIDASE AND PEROXIDASE ACTIVITIES AFTER GAMMA IRRADIATION OF PLANTS WITH VARIOUS RADIOSENSITIVITIES. Kuzin, A. M.; Korolev, N. P. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 464-9(1966). (In Russian).

It was demonstrated that there is an increase in the polyphenol oxidase and peroxidase activity in the sprouts of radiosensitive plants immediately after irradiation. The radiosensitivity for four plants of the legume family is correlated with the general increase in the activity of these enzymes after irradiation. In the Cruciferae, there is also an increase in the total activity of these enzymes in the more radiosensitive representative (stock). Radish, as the most radioresistant of all the investigated plants, exhibited no change in the activity of the enzymes studied. It was hypothesized that the electrophilic character of the quinones that arise in radiosensitive plants may cause the same effects as alkylating agents, which also possess electrophilic properties. (auth)

6720 INFLUENCE OF THE CONDITIONS OF GROWTH ON THE MANIFESTATION OF RADIOBIOLOGICAL EFFECTS AFTER TREATMENT OF SEEDS WITH FAST FISSION NEUTRONS. Ponomarev, G. V.; Batygin, N. F. (Krasnoyarsk Scientific Research Inst. of Agriculture, Agrophysical Scientific Research Inst., Leningrad). Radiobiologiya, 6: 470-3(1966). (In Russian).

The manifestation of radiobiological effects after exposure of seeds in a reactor depends substantially upon the conditions of postradiation germination. In the presence of readily accessible elements of nutrition in the surrounding medium, the degree of injuries induced by fast neutrons can be substantially weakened. However, we were unable to restore the fertility of the M_1 plants solely by additions of the basic elements of nutrition. The addition of cobalt, copper, boron, or zinc to a substrate provided with the basic elements of nutrition promoted a rise in the average fertility of the M_1 plants to that of the plants from seeds untreated in the reactor. (auth)

6721 ANTITUMORAL EFFECT OF INERT GASES AND LOW-MOLECULAR NARCOTICS. 6. PATHWAY OF OXYGEN TRANSPORT AND LOCALIZATION OF THE DIFFUSION OBSTACLE IN IRRADIATION OF BEAN SPROUTS IN THE PRESENCE OF COMPRESSED GASES. Kalnii, V. S.; Paribok, V. P.; Genter, E. I. (Inst. of Cytology, Leningrad). Radiobiologiya, 6: 446-50(1966). (In Russian).

Compressed nitrogen (25 atm), added to air, does not influence the oxygen consumption by bean sprouts (Vicia faba). Nitrogen under pressure prevents diffusion of oxygen into the intercellular spaces of the root, and as a result, exerts a protective effect in the irradiation of bean sprouts. (auth)

6722 EFFECT OF X-RAY ON SOME WHEAT CHARACTERS. Mohamed, H. A. (Bahtim Experimental Station, Cairo). Wheat Inform. Serv. (Jap.), No. 14, 14-15(1962).

Seed of two Triticum vulgare varieties, namely Tosson and Giza 144, one T. durum wheat variety, namely Baladi Bahtim, and Einkorn wheat were exposed to different x-ray treatments. Total doses amounted to 12,000, 18,000, or 24,000 R. The seed were dry or had been soaked for 24 hr in water prior to x-ray treatment. Treated and untreated seed were planted in a greenhouse in steamed soil and replicated 4 times, using 25 or 50 seed in each replicate. The time for seedling emergence was delayed one day when the seed was dry at the time of x-ray exposure and delayed 2 to 3 days when the seed was soaked for 24 hours prior to x-ray treatment. The percentage of seedling emergence decreased when seed was exposed to x rays. Differences in the percentage of seedling emergence between control and irradiated seeds were highly significant in the case of the soaked seed when results were analyzed statistically. Length of the seedlings was measured and average length calculated for each replicate, and the results were analyzed statistically. Differences were highly significant in the case of soaked seed. In the case of the dry seed, differences were highly significant only for the high-dose x-ray treatments. (BBB)

6723 ALTERATIONS OF CELL PERMEABILITY PRODUCED BY LOW DOSES OF X IRRADIATION. Srb, Vladimir (Charles Univ., Hradec Kralove, Czechoslovakia). Biologia, 20: 877-82 (1965). (In Czech).

The effects of 25, 50, 1000, and 250 R of x irradiation on permeability of epidermal tissue cells of onions, Allium cepa, were evaluated. Permeability changes were measured using 0.5M KNO_3 and 1M glycerol. There were no significant differences between the effects of the various radiation doses used. The most important finding was that changes in permeability were induced by doses as low as 25 or 50 R. This indicated that the cytoplasmatic lipoprotein cell membranes were extremely radiosensitive. Early changes in cell permeability could be used as a test for radiation damage. References cited, 41. (BBB)

6724 THE DURATION OF THE G_1 PHASE OF THE MITOTIC CYCLE AND ITS RELATION TO RADIOSENSITIVITY. Clowes, F. A. L. (Oxford Univ.). New Phytol., 64: 355-9(Oct. 1965).

Duration of phases of the mitotic cycle in four regions of the root meristem of Zea mays was determined by pulse labeling with ^3H-thymidine. S, G_2, and mitosis are similar in length in all the regions, but G_1 differs considerably and is largely responsible for the diversity in rates of mitosis. G_1 is nonexistent in the cap initials, 151 hr in the quiescent center and 2 to 4 hr in the stele. After x irradiation the cap initials undergo the greatest increase in the duration of the mitotic cycle, e.g., from 12 to 150 hr, 6 days after receiving 1800 rad. The number of cells with micronuclei after severe acute irradiation is higher in the cap initials than elsewhere. After artificial synchronization of mitosis by 5-aminouracil, an analog of thymine with radiomimetic properties, the cap initials hardly reach the normal level of mitotic index even at the peaks of synchronized mitoses whereas the other meristematic cells exceed their normal mitotic indices by large margins. These data suggest that it is the ratio of the lengths of G_1 to the rest of the mitotic cycle that decides how resistant a tissue will be to radiation and they lead to a general explanation of the law that rapidly dividing cells are more susceptible than slowly dividing cells. The extreme radiosensitivity of the cap initials and the high resistance of the quiescent center are correlated with the brevity of G_1, in the former and the prolongation of G_1 in the latter. The fraction of the mitotic cycle spent in G_1 (when each nucleus has only the 2C amount of DNA) therefore probably determines both radiosensitivity and rates of division. (BBB)

6725 EVALUATION OF SPONTANEOUS, CHEMICAL, AND RADIATION-INDUCED MUTATIONS IN PINACEAE. Mergen, Francois. World Consultation Forest Genet. Tree Improvement, Proc., Stockholm, Aug. 23-30, 1963. Rome, Food and Agriculture Organization of the United Nations, [1964]. 14p.

A ^{137}Cs (9500 C) source was placed in a natural pitch pine-oak forest to study the effect of radiation on a natural forest community. At an exposure level of 15 R/day severe growth inhibition of shoot elongation occurred in pine six months after irradiation had started. The effect on the reproductive capacity of the pine trees was studied. During the first season trees receiving 82 R/day and higher were unable to resume cell division in the sporogenous tissue. Microspore mother cells were found on trees receiving 75 R/day, and at 56 R/day meiosis with subsequent formation of tetrads took place. The highest level at which mature microspores were collected was 14 R/day. The percentage of microspore cells with visible chromosomal aberrations increased with an increase in exposure, e.g.: 0.36 R/day, 1%; 7 R/day, 2%; 11 R/day, 12%; and 56 R/day, 76%. When one-year-old Pinus rigida seedlings were exposed to various intensities of γ rays from a ^{60}Co source, observations were made on the ability of the damaged seedlings to produce sprouts from dormant buds, below the ground line, that were partially shielded by the soil. Photographs are provided showing the effects of γ irradiation on pine seedlings. (BBB)

6726 RADIATION EFFECTS OF RADIOACTIVE COBALT ON THE GROWTH AND DEVELOPMENT OF CORN. Kietze, V. T. pp 55-60 of Rol Mikroelementov v Protsesse Rosta i Razvitiya Rastenii. Bluzmanas, P. I.; Dagis, I. K. (eds.). Vilnyus, USSR, Izdatelstvo Mintis, 1965. (In Russian).

The influence of radioactive cobalt on the rhythm, growth, and development of corn was studied in Latvia, USSR, where the weather interferes with the normal ripening of the plant. It was observed that optimum radiation doses of 500 and 2000 R stimulated seed germination sprouting, and growth of the plants, reduced the blooming period, and increased the harvest. (R.V.J.)

Radiation Effects on Microorganisms

Refer also to abstract 6747.

6727 (NP-16399) RADIATION SENSITIVITY OF E. COLI DURING THYMINELESS DEATH. Ganguli, Nati; Bhattacharjee, S. B. (Saha Inst. of Nuclear Physics, Calcutta (India)). [1965]. 9p. Dep. mn.

Sensitivity to x radiation was determined in a ^{15}T-strain of E. coli following different periods of incubation at 37°C in a thymineless medium. The cells became progressively more sensitive to x rays with increasing incubation time in the thymineless medium. When x-irradiated cells were incubated in the absence of thymine, the cells became more sensitive to thymineless death with increasing doses of pre-x-irradiation, and the initial plateau in the thymineless survival curve disappeared. Results indicated that both thymineless death and x-ray-induced killing were due to events occurring in the nuclear material. Treatment with one agent sensitizes the cells to subsequent treatment with the other agent by producing non-lethal damage in the nuclei. (H.G.D.)

6728 COMBINED EFFECTS OF IONIZING RADIATION AND MUCOLYTIC LIDASE FERMENTATION ON EXPERIMENTAL RADIATION BACTEREMIA. Ter-Avetisyan, A. T. (Div. of Radiobiology, Academy of Medical Sciences, USSR). Biol. Zh. Arm., 19: No. 6, 29-34(June 1966). (In Russian).

The highest percentage of bacteremia in mice was observed from the combined effects of x radiation at 400 R and lidase (65.6%), followed by 200 R and lidase (29.8%), then by radiation alone at 400 R (4.5%), and finally 200 R (0.1%). The combined effects of x radiation at 200 and 400 R and lidase fermentation produce the invasion of microbes into the blood, liver, and spleen of mice in the first stage of the study; sowing of the blood and organs does not disappear in the first 30 days of the post-irradiation period; the combined effects of x radiation at 400 R and lidase causes bacteremia in 100% of rabbits after 6 to 10 hours, and this bacteremia does not disappear in the 30 days of study. 50% died during this period. In rabbits receiving only injections of lidase, bacteremia begins only after 24 hours and disappears 2 days after the lidase injection. In rabbits exposed only to radiation, bacteremia begins in 10 days and the blood is purified of microorganisms in 30 days; there are no fatalities. (tr-auth)

6729 STABILITY OF DNA IN ESCHERICHIA COLI B/r AND B_{s-1} IRRADIATED WITH ULTRA-VIOLET LIGHT. Suzuki, Kenshi; Moriguchi, Etsuko; Horii, Zen-ichiro (National Inst. of Radiological Sciences, Chiba City, Japan). Nature, 212: 1265-7(Dec. 10, 1966).

The DNA of Escherichia coli B_{s-1}, a uv-sensitive mutant of strain B, was shown to be made very unstable by uv-irradiation, whereas the DNA of B/r, a uv-resistant mutant of strain B, was much more resistant to uv in this respect. Degradation of DNA in uv-irradiated B_{s-1} was suppressed partially by exposure to visible light. Hence, it is suggested that the stability of DNA is influenced by structural modifications of the molecule. Reasons for the instability of DNA in uv-irradiated B_{s-1} are considered. (H.G.D.)

6730 EFFECT OF SUBLETHAL X-RAY DOSES ON BACTERIAL CULTURE IN LOGARITHMIC GROWTH. Galdiero, F.; Fragomele, F. (Univ., Naples). Riv. Ist. Sieroterap. Ital., 40: 95-103(Mar.-Apr. 1965). (In Italian).

Survival curves were compared for cultures of Bacillus subtilis and Escherichia coli B irradiated at different temperatures by sublethal doses of x rays. In general, the survival curves (percentage surviving cells vs x-ray dose) were sigmoidal in shape and depended on the growth rate of the cells at the time of irradiation. B. subtilis and E. coli irradiated in the logarithmic growth phase at 19,000 R at 28, 37, and 42°C gave sigmoidal curves, whereas at 100,000 R an exponential type of curve was noted. After the 100,000-R dose the latent period for growth of cells from irradiated cultures inoculated in liquid medium was prolonged. This latent period depended on temperature at the time of irradiation; it was shorter at 37°C than at 28 or 42°C. This latent period was not found with nonirradiated cells. The results indicate that the regrowth of irradiated cultures depends on multiple factors acting in succession. (BBB)

6731 RELATIONS BETWEEN STREPTOMYCIN AND RADIORESISTANCE IN AZOTOBACTER CHROOCOCCUM. Mueller, Hermann P. (Kernforschungsanlage, Juelich, Ger.). Arch. Mikrobiol., 53: 59-66(1966). (In German).

Suspensions of Azotobacter chroococcum containing 10^8 to 10^9 cells/ml were irradiated with 0.5 to 20 kR of x radiation during the logarithmic growth phase. Mutants resulting from the irradiations were characterized on the basis of colony size, form, and color. Their resistance to streptomycin was tested, and 60% showed differences from the original stock. Resistance was increased in about 20% and was decreased in about 40%. The mutants that were susceptible to streptomycin were also radiosensitive. Mutants that had an increased streptomycin resistance were relatively resistant to irradiation. (BBB)

6732 USE OF PHYTOHEMAGGLUTININ AS AN AID TO CELLULAR REPAIR DURING CONSTANT X-IRRADIATION. Aldridge, Clifton; Gray, Johanna G.; Clark, J. B. (Avco Biophysics Lab., Norman, Okla. Univ. of Oklahoma, Norman). Contract NAS2-1545. Proc. Okla. Acad. Sci., 44: 219-20(1964).

Growth rates were determined in x-irradiated E. coli to investigate the radioprotective effects of phytohemagglutinin. The addition of phytohemagglutinin before or after exposure to radiation, or addition to the plating medium, had no significant effect upon the recovery of irradiated cells. However, even trace amounts of phytohemagglutinin during irradiation prevented radiolysis and allowed growth of the cells to continue. (H.G.D.)

6733 STUDY, IN CULTURE, OF THE PRODUCTION OF ROUS VIRUS BY CONTACT BETWEEN THE CELLS OF XC SARCOMA OF THE RAT AND THE CELLS OF THE CHICKEN EMBRYO. Vigier, Philippe; Svobada, Jan (Institut de Radium, Paris. Inst. of Experimental Biology and Genetics, Prague). Compt. Rend., 261: 4278-81(Nov. 15, 1965). (In French).

Rat sarcoma XC cells, grown in a mixture of serum and Difco bactotryptose phosphate, were irradiated with cobalt-60 at 5,000 R and inoculated into the chorio-allantoic membrane of the chick egg. A radiation dose of 5,000 R inhibits the multiplication of the XC sarcoma cells but does not destroy their virus-producing capacity. Transformed and virogenic chicken cells develop in culture after contact with the XC sarcoma cells. The presence of an auxiliary virus in the chicken cells is not required. (H.L.W.)

6734 RADIATION SENSITIVITY OF ESCHERICHIA COLI DURING THYMINELESS DEATH. Ganguli, Nati; Bhattacharjee, S. B. (Saha Inst. of Nuclear Physics, Calcutta). Radiat. Res., 29: 445-9(Nov. 1966).

Cells of a 15_T-strain of E. coli while undergoing thymineless incubation at 37°C were taken out at different periods of incubation, and their x ray sensitivities were determined in the cold at the dose rate of 6 krads/min. It was found that, with the increasing incubation in thymineless medium before irradiation, the cells became progressively more sensitive to x rays. In the reverse experiment, when x-irradiated cells were incubated in the absence of thymine, the cells became more susceptible with increasing doses of preirradiation. The initial plateau in the thymineless survival curve also vanished for such x irradiated cells. The results were considered to indicate that both thymineless death and x-ray-induced killing were due to events occurring in the nuclear material of the cells. One treatment sensitizes the cells to later treatment by other agents by introducing nonlethal damages in the nuclear material. (auth)

6735 DNA-AGAR ANNEALING OF RESIDUAL DNA AFTER DEGRADATION BY IONIZING RADIATION. Swez, J.; Pollard, E. C. (Pennsylvania State Univ., University Park). Radiat. Res., 29: 475-82(Nov. 1966).

Residual DNA after degradation in Escherichia coli $15T^-L^-$ initiated by ionizing radiation was examined with respect to homology with normal DNA from the same microorganism with the technique for DNA–agar annealing. The conclusion that we reach from these experiments is that, within the limits of accuracy of the experimental points, the DNA is degraded randomly, and no part is preferentially selected. (auth)

6736 NOTE ON THE SPORULATION OF SOME SEED BORNE FUNGI UNDER NEAR ULTRA-VIOLET LIGHT. Howell, P. J. (Dept. of Agriculture and Fisheries, Edinburgh). Proc. Int. Seed Testing Ass., 29: 155-8(1964).

The effect of uv on the sporulation of fungi was studied using a fluorescent blacklamp (Philips Type MCF/U, 40 w). Irradiation of oat seed germinating on blotters in Perspex chambers was tested for sporulation of Helminthosporium avenae. The blacklamp was run continuously for 7 days. This was followed by a period of darkness for 24 hr. Good sporulation of Alternaria tenuis and H. avenae was obtained in certain treatments. There were considerably more seeds with sporulating H. avenae in the near uv light plus dark treatment than in various other treatments, suggesting that near uv light had initiated sporulation. In the other treatments sporulation was sparse. Irradiation did not appear necessary for sporulation of A. tenuis. The sporulation count was increased in all the containers when the plates were exposed to the near uv light. Spores of H. avenae were few in number in the ordinary petri dishes compared with the number found on seeds in polystyrene containers under the near uv light. The results confirm that the use of fluorescent blacklamps giving near uv light may be valuable in seed disease assessment, provided they are used in conjunction with materials that can transmit the radiation. Pyrex glass and clear polystyrene seem to be most useful. (BBB)

6737 EFFECTS OF ULTRAVIOLET RADIATION ON MACROMOLECULAR SYNTHESIS IN ESCHERICHIA COLI. Swenson, P. A. (Univ. of Massachusetts, Amherst); Setlow, R. B. J. Mol. Biol., 15: 201-19(Jan. 1966).

An examination was made of some uv-sensitive and -resistant

strains of E. coli B, of some factors that influence the inhibition of DNA synthesis by uv radiation, and of some factors related to the repair of such lesions. The quantitative analysis of the inhibition of DNA synthesis is described in terms of a model in which a pyrimidine dimer completely blocks DNA synthesis. The consequences of uv damage to DNA on synthesis of RNA and protein in radiation-resistant and -sensitive strains were also examined. (TSS)

6738 INVESTIGATION OF THE MOLECULAR MECHANISM OF SYNCHRONOUS NUCLEUS DIVISION IN PHYSARUM POLYCEPHALUM. EFFECTS OF FUSION AND X IRRADIATION ON MITOSIS. Bollig, T. Heidelberg, Univ., 1965. 57p. $2.00 Gmelin, AED-Diss, 65-366.

Thesis.

After fusion of 2 plasmodia of Physarum polycephalum in different mitosis phases a new synchronous mitosis rhythm appears. X irradiation of plasmodia delays the start of synchronous mitosis especially if the irradiation occurs immediately after mitosis. This delay can be partially reduced by fusion with unirradiated plasmodia. (auth)

Radiosterilization and Radiopreservation

Refer also to abstract 6144.

6739 (COO-1283-40) IRRADIATION PRESERVATION OF FRESH-WATER FISH AND INLAND FRUITS AND VEGETABLES. Final Report. Emerson, J. A.; Kazanas, N.; Gnaedinger, R. H.; Krzeczkowski, R. A.; Seagran, H. L. (Bureau of Commercial Fisheries, Ann Arbor, Mich.); Markakis, P.; Nicholas, R. C.; Schweigert, B. S. (Michigan State Univ., East Lansing); Kempe, L. L. (Michigan Univ., Ann Arbor). Aug. 1966. Contract AT (11-1)-1283. 68p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The application of ^{60}Co γ rays at substerilizing doses to the extension of the refrigerated shelf life of commercially significant Great Lakes fishery products and the potential usefulness of γ radiation for controlling the activity of the enzymatic antimetabolite of whole fish and fishery products were investigated. Shelf life extension of yellow perch fillets irradiated to 0.1 and 0.2 megarad and stored at 33°F appeared to increase the product's shelf life approximately 2-fold. The level of 0.2 megarad provided only a slightly greater extension of shelf life than did the level of 0.1 megarad. As previously demonstrated by Kazanas (1966), Pseudomonas and to a lesser degree Achromobacter were the predominant organisms at the time that nonirradiated fillets were spoiled. Pseudomonas was eliminated at both dose levels (0.1 and 0.2 megarad), and the Achromobacter group mostly comprised the residual flora. At that time the fillets were organoleptically evaluated as unacceptable. The shelf life extension of simulated commercial-scale packs of yellow perch fillets irradiated to 0.3 megarad and stored at 36°F was extended only by approximately 2.5-fold. The unusually high initial microbial load (10^7) and, possibly, the milt (spawning season) on the fillets contributed to the relatively early unacceptability of the irradiated and nonirradiated fillets. Organoleptic evaluations of irradiated (0.2 and 0.3 megarad) and refrigerated (33°F) channel catfish indicated the usual shelf life extension for freshwater fish (2- and 3-fold). A mold that was picked up during filleting and that reached considerable numbers through fillet storage was resistant to 0.3 megarad, but could have been eliminated from the fillets by employing better in-plant sanitation practices. Organoleptic evaluations of lake herring irradiated to 0.3 megarad and refrigerated at 33°F showed that blandness of this product rather than spoilage was the cause for relatively early fillet unacceptability. The predominant organisms on yellow perch fillets at the plant level were proteolytic. The normal flora of fresh, yellow perch fillets at the net level contained a small number of Pseudomonas, which increased markedly by commercial handling. Yeasts and molds were picked up at the plant level. Good sanitation practices could contribute materially to minimizing the irradiation dosage necessary to achieve commercially significant extension of shelf life. The radiosensitivity of the enzyme thiaminase was directly dependent upon sample temperature (during irradiation) and irradiation dosage. Source of thiaminase (species of fish), chemical inhibitors, and the amount of water present during irradiation also influenced thiaminase sensitivity to gamma rays. The commercial application of radiation to completely inactivate thiaminase in situ in whole fish and fishery products did not appear to be economically feasible, inasmuch as it requires a radiation dosage of 4 megarads at room temperature to inhibit only 23 to 95% (species dependent) of the thiaminase activity in whole fish. (H.G.D.)

6740 (RLO-1950-1) EFFECT OF IRRADIATION ON THE MICROBIAL FLORA SURVIVING IRRADIATION PASTEURIZATION OF SEAFOODS. Sinnhuber, R. O.; Lee, J. S. (Oregon State Univ., Corvallis. Dept. of Food Science and Tech.). Apr. 15, 1966. Contract AT(45-1)-1950. 66p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The storage life of irradiated Dungeness crabmeat was extended three-fold by exposure to 0.1 Mrad x radiation and seven-fold by exposure to 0.4 Mrad. The microbial flora, predominantly Achromobacter sp., of crabmeat were not significantly changed by irradiation. The storage life of Pacific oysters was extended four-fold by 0.1 Mrad and ten-fold by 0.4 Mrad doses of x radiation. The spoilage of non-irradiated oysters was due to Lactobacillus and Pseudomonas organisms. Lactobacillus predominated as the spoilage organism in samples exposed to 0.1 Mrad while Achromobacter sp. caused spoilage of samples exposed to 0.4 Mrad radiation dose. The survival characteristics of inoculated Salmonella typhimurium in irradiated oysters and the combined effects of sodium benzoate and irradiation on the survival of Salmonella in oysters were studied. Results showed that a greater number of Salmonella cells were recovered from benzoate treated oysters than from untreated samples, although benzoate reduced the growth of natural flora in both irradiated and non-irradiated oysters. Possible mechanisms for the effects of sodium benzoate on Salmonella typhimurium viability in irradiated oysters are discussed. (C.H.)

6741 CONSUMER SURVEY FOR ACCEPTANCE EVALUATION OF CURED HAM TREATED BY A COMBINATION OF HEAT AND IRRADIATION. Hansen, Poul-Ivar E. (Danish Meat Research Inst., Roskilde). Food Technol., 20: 99-103(Feb. 1966).

Commercially sterile canned hams were produced by a combination of a heat treatment to a center temperature of 65-70°C plus doses of about 0.5 Mrad γ radiation. This gave a ham with a shrinkage of 6-12%, depending on size, compared to a 25-30% shrinkage in normally heat-treated controls. The irradiated hams had good texture and color. It was previously found that some off-flavor arose, and experienced taste panels scored the irradiated hams 1½-2 points lower than control hams on an 11-point hedonic scale. The flavor of this cured ham was then compared by an untrained, consumer panel with the flavor of cured ham conventionally heat-treated, on a 5-point hedonic scale. The panel consisted of 150 families, selected at random in a limited geographical area, about 350 people in all. They were informed in advance that the experiment involved irradiated food. In two consecutive weeks they received slices of ham from either an irradiated ham or a control ham, the four possible combinations of irradiated and unirradiated ham being used. By means of test-retest data and check questions the panel was shown to be consistent, and data for identical samples in various groups indicated that randomizing of the panel into different groups had succeeded. A higher significant difference in flavor was found between irradiated and control ham. The difference in score in groups where a direct comparison was possible was higher than ¾ scale point in favor of the control ham. The results thus confirm the findings of small expert taste panels made earlier. Most unfavorable comments were connected with the flavor of the irradiated ham, taste as well as smell. The smell was characterized as burnt, sulfurous, and in a few cases, repulsive. Many tasters characterized the irradiated samples as the juicier of the two. This confirms the results of experienced taste panels, who found superior texture and consistency in irradiated hams. It appears that the consumer attitudes to irradiated vs conventionally heat-treated canned hams could have been predicted closely from the results obtained by trained taste panels. (BBB)

6742 WHOLESOMENESS OF γ-IRRADIATED POTATOES. II. FEEDING EXPERIMENTS WITH PIGS. Jaarma, Maire; Bengtsson, Goesta (Royal Univ., Stockholm). Nutr. Dieta, 8: 109-29(1966).

Previous work indicated that no obvious unfavorable effects could be observed in pigs and rats fed irradiated potatoes. The investigation was repeated with larger groups of animals to ascertain whether the feeding of γ-irradiated potatoes to pigs could cause any toxic effects. Whether this diet, given for a longer period to pigs in two generations, has had any influence on the fertility or on the bacon quality of the animals, was also examined. Three common Swedish varieties of white potato, Bintje, King Edward, and Magnum Bonum, were used in equal quantities. The main part of the tubers was irradiated in a ^{60}Co source at a dose rate of 150 R/sec. A smaller portion was irradiated at the lower dose rate, 620 R/hr in a ^{137}Cs source. The dose in all experiments was 14 to 15 krad. Irradiated and nonirradiated control potatoes were fed to fattening and breeding pigs (Swedish Land Race), a total of 116 pigs in two generations. Potato feeding was introduced when the pigs had reached a weight of 25 kg, the ration of potatoes being gradually increased from 0.5 to 4 kg per pig per day. Each fattening pig received about 200 kg potatoes, each sow in the breed-

ing series a total of 900 kg potatoes up to the end of the lactation, and each boar 600 to 700 kg. The general health, growth, and fertility of the animals were observed. During the feeding period samples of blood were taken regularly. The test included red and white blood cell counts, determination of the hemoglobin concentration, and of the activities of the enzymes ornithine-carbamoyltransferase (OCT), aspartate-aminotransferase (GOT), and alanine-aminotransferase (GPT) in plasma. After slaughtering, some organs were examined histologically. No divergence from the control animals could be observed. Quality tests of the meat products did not give any significant differences between the groups, nor could any other detrimental effects be found in the pigs fed the irradiated potatoes. A tendency towards faster growth in the pigs fed irradiated potatoes was noted. In many of these animals, a faster increase in the hemoglobin level and a high hemoglobin concentration were also observed at the end of the experiment. Determinations of enzyme activities as well as blood cell counts gave the same results for both groups. The fertility and the number of pigs in each litter were also equal. Furthermore, the second-generation pigs provided no indication that irradiated potatoes might give rise to deleterious effects. (BBB)

6743 USE OF IONIZING RADIATION IN FOOD PRESERVATION. Ley, F. J. (Wantage Research Lab., Eng.). Chem. Ind. (London), No. 27, 1183-4(July 2, 1966).

A report is given of the use of ^{60}Co γ radiation and fast electrons for food sterilization and pasteurization. Apart from economic considerations the choice of source largely depends on the degree of penetration required. Gamma rays may be used for the treatment of food with a target depth up to about 30 cm whereas with electrons, the depth is restricted to several centimeters. However, electrons can be produced with extremely low penetrating power for treatment of surfaces only. Potential applications of radiation in food preservation were classified in relation to the total dose required to produce the desired effect. The max dose proposed is 4.8 Mrad with reference to the sterilization of non-acid foods, in particular fresh meat and fish. The dose is calculated to eliminate Clostridium botulinum type A spores, since room temperature storage is used after irradiation. Such high dose treatment has met with limited success since unacceptable odor and flavor changes have been apparent, and such treatment does not completely inactivate enzyme activity so that quality loss occurs during storage. Research in the United Kingdom has been concentrated mainly on processes involving doses of 0.1 to 0.5 Mrad, which is much lower than that recommended for sterilization, and detrimental effects on quality are largely avoided. The aim is to increase the refrigerated storage life (0°–5°C) of commodities such as fish, poultry, and meats. The use of radiation to eliminate Salmonella from certain foods is discussed. Gamma radiation may be ideal for the treatment of frozen horsemeat imported as pet food in large frozen blocks. It could be treated with a radiation plant ideally situated near the dockside. The meat would remain frozen and packed in its original container during treatment. Entomological research has demonstrated the effectiveness of a dose of about 20,000 rad for the disinfestation of stored grain. The question of the wholesomeness of irradiated food is also considered briefly. (BBB)

6744 PRESERVATION OF THE SARDINE SARDINELLA MELANURA BY LOW-DOSE GAMMA RADIATION. Hashish, S.; Hussein, M. F.; Abdel-Baki, M. M.; Roushdy, H. M.; Hassan, Y. M. (Atomic Energy Establishment, Cairo). J. Fish. Res. Board Can., 23: 601-6(Apr. 1966).

Effectiveness of low doses of γ radiation for fish preservation as compared with chlortetracycline (CTC) treatment was examined. Irradiation of the sardine Sardinella melanura with 15,000 or 23,000 rad from a ^{60}Co source increased the storage life at 1°C. During storage the rates of increase in pH, total volatile nitrogen (TVN), tyrosine value (TV), and bacteriological count (BC) were diminished by raising the radiation dose and those for TVN, TV, and BC also by treatment with CTC. The edibility periods, as judged organoleptically, were 4 days for untreated samples, 8 and 11 days for samples irradiated at 15,000 and 23,000 rad, and 12 days for samples treated with CTC. After 8 days of storage the TVN and TV values for samples treated with CTC were lower in relation to the values just after treatment than were those for samples irradiated at either dose. At 8 days, the BC values for samples treated with CTC were 136 times those just after treatment, in comparison with 11 times for the irradiated samples; however, the counts at 8 days were less than half as high for samples treated with CTC as for those irradiated at 23,000 rad. The protection factors were 2 and 2.75 for the irradiated samples and 3.0 for the CTC treatment. Though the BC for treatment with CTC was much higher than for either of the irradiation treatments, the actual counts at 8 days after treatment were less than half as high for CTC as for irradiation (3.4 million vs 7.5 and 26 million). That the BC value, which is a direct index of the rate of fish deterioration as a result of bacterial growth, was lower for irradiation than for treatment with CTC is in keeping with earlier findings that antibiotics have bacteriostatic effects while irradiation has bactericidal effects. (BBB)

6745 GAS CHROMATOGRAPHIC AND MASS SPECTRAL IDENTIFICATION OF SOME VOLATILE COMPONENTS OF GAMMA-IRRADIATED MILK FAT. Khatri, L. L.; Libbey, L. M.; Day, E. A. (Oregon State Univ., Corvallis). J. Agr. Food Chem., 14: 465-9(Sept.-Oct. 1965).

The off-flavor of irradiated milk fat results from hydrolytic rancidity, oxidative rancidity, and the presence of components with a candle-like odor, probably from carbonyls with medium to long carbon chains. Gas-liquid chromatography (GLC) of volatiles from irradiated milk fat was used to characterize these compounds to understand the effect of irradiation better. Milk fat, sealed in cans under vacuum, was γ irradiated (^{60}Co) at 4.5 Mrad. The small amount of oxygen present in the headspace of the cans was consumed, while H_2, CO, CO_2, and CH_4 were produced. The irradiated fat was analyzed for monocarbonyls by forming their 2,4-dinitrophenylhydrazone derivatives. The volatiles of the irradiated milk fat were obtained by vacuum-steam distillation, and the components in the distillate were identified by rapid-scan mass spectrometry of the ethyl ether extract. n-Alkanes and 1-alkenes from C_5 to C_{17}, some alkadines, n-alkanals, short-chain fatty acids, and certain γ and δ lactones were among the compounds identified. Traces of the C_5, C_6, C_9, and C_{12} alk-2-enals but no alk-2,4-dienals were identified. Qualitatively, the methyl ketones did not show a significant change upon irradiation; however, they are present in much larger quantities in irradiated milk fat. The origin of methyl ketones and long-chain aldehydes is probably via hydrolytic cleavage of ester and enol-ether linkages. Thus, irradiation-induced hydrolysis of ester and enol-ether linkages is a likely mechanism accounting for the production of ketones and long chain aldehydes in irradiated milk fat. The formation of short-chain aldehydes may be explained by a similar mechanism. (BBB)

6746 ERADICATION OF THE SCREWWORM FLY: AN AGENT OF MYIASIS. Baumhover, Alfred H. (Dept. of Agriculture, Oxford, N. C.). J. Amer. Med. Ass., 196: 240-8(Apr. 18, 1966).

Development of the radiosterilized male technique for elimination of the screwworm fly and other parasitic insets is reviewed. Eradication of the screwworm from Curacao by this method is considered from the point of view of mass production, sterilization, release, and field evaluation of the project. For irradiation, a 480 Ci ^{60}Co unit was used for a 2000 mi^2 test with an initial dose rate varying from 788 to 910 R/min. To completely sterilize the screwworms, 8000 R was delivered to papae at 5.2 to 5.7 days of age. During a two-year campaign in Florida, 3.7 billion screwworm pupae were produced. Twenty light aircraft were used to release flies over a max area of 85,000 mi^2, and peak employment totaled 500. Irradiation studies showed that a sterilizing dose of radiation could be administered to screwworms without seriously affecting longevity or male competitiveness. Economic aspects of the program are discussed. (TSS)

6747 RADIATION DAMAGE TO STAPHYLOCOCCUS AUREUS. Slabyj, B. M. 11p. (CONF-660539-5). ORAU. Gmelin, AED-CONF-66-114-6.

From American Society for Microbiology, 66th Annual Meeting, Los Angeles.

Storage of γ irradiated crabmeat, previously inoculated with Staphylococcus aureus at temperatures above 8°C resulted in an increase of viable bacteria after a lag time proportional to the radiation dose. The effects of the growth of bacteria that had survived irradiation and of the recovery of previously inactivated bacteria on the number of viable bacteria were investigated, using penicillin to kill actively growing cells. Results indicated that irradiated Staphylococcus cultures did not exhibit significant radiation recovery under conditions stimulatory to growth, that radiation induced increased reproductive and probably metabolic activity, that induced changes were heritable only in the primary culture, and that even normal cells showed a fluctuation in reproductive activity during log phase. (C.H.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 6813 and 6860.

6748 (RFP–729) FORTRAN II COMPUTER PROGRAM FOR ANALYSIS OF ELLIPSOMETRIC DATA. Larson, C. A. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Dec. 6, 1966. Contract AT(29-1)-1106. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An accurate and time-saving procedure has been developed for the analysis of ellipsometric data related to studies of thin film formations on metal surfaces. In processing the theoretical data necessary for these studies, the margin of accuracy attained was considered sufficient. In comparing test data with work done in these areas by the recognized efforts of R. J. Archer and F. L. McCrackin, the results differed by 0.02 percent. Since data to be processed are extensive and contain complex formulas requiring reduction to simplified interpretive solutions, accurate analyses are in demand. To date, results obtained with digital computers have offered considerable advantages over linear approximations or other solutions. A procedure was initiated utilizing a Fortran II language system and programing an ASI 210 digital computer to perform the evaluation operations. The limited memory size of the available computer made it necessary to prepare the program, or sequence of instructions, in a series of four functional units or "links." (auth)

Corrosion and Erosion

6949 (AD-634909) THE PROTECTION OF TANTALUM FROM OXIDATION AT HIGH TEMPERATURES WITH ALUMINIUM–50 PERCENT TIN COATINGS. Moreton, R. (Royal Aircraft Establishment, Farnborough (England)). Jan. 1966. 21p. (TR-66017). CFSTI $4.00 cy, $0.50 mn.

An Al–Sn coating was investigated as a protection against oxidation of tantalum sheet—a possible material for the combustion chambers of ramjets of hypersonic aircraft. Coatings containing equal parts by weight of Al and Sn were deposited from acetone slurries of the two metals and made impermeable by heating in vacuum for ½ hr at 1050°C. The coatings which then consisted of a $TaAl_3$ covered with Al–Sn alloy, were assessed by oxidation tests, measurements of substrate hardening, and mechanical tests. Tantalum was protected for up to 37½ hr at 1500°C and 3⅓ hr at 1600°C in air. Some self-healing occurred due to oxidation of molten Al–Sn alloy at defects in the outer oxide layer. Substrate hardening due to nitrogen penetration occurred in test-pieces where no signs of failure had been seen after heating in air at 1500°C. Tensile tests however showed that coated tantalum could be heated in air at 1500°C for up to 8 hr without loss of ductility at room temperature. (auth)

6750 (AECL–2603) COMPARISON OF WEAR RATES IN WATER FROM DIFFERENT TEST MACHINES. Dunn, J. T. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug. 1966. 22p. Dep. mn. AECL $1.00.

The wear rates of different material combinations tested as ¼-in.-diameter, flat ended riders reciprocating on a flat surface, were found to be the same, or less than, the wear rates of the same combinations tested as ¾-in. journal bearings. Because of this correlation it appears that the extensive wear results obtained at AECL using journal bearing specimens can be used, with a reasonable degree of confidence, to predict the maximum wear of flat sliding surfaces in water. This correlation may not hold for surfaces ¼ inch in diameter and smaller since it was shown that the wear of small brass riders on AISI type-304 stainless steel was stress dependent at contact stresses over 400 lb/in.^{2} (auth)

6751 (ARF–B229-16) HIGH-TEMPERATURE BERYLLIUM CORROSION PROTECTION. Evaluation of Coatings Anodized by Brush Beryllium Corporation. Phase Report, May 15, 1962–November 15, 1962. (Armour Research Foundation, Chicago, Ill.). Jan. 22, 1963. Contract AT(11-1)-578. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Atomics International, Canoga Park, Calif.

The use of anodizing as a means of protecting S8ER beryllium neutron reflectors from atmospheric corrosion during ground testing has been evaluated. Anodic coatings applied by the Brush Beryllium Company were oxidized at varying temperatures in dried air and reduced oxygen content atmospheres to determine coating life. The results indicate that a coating life of at least 3000 to 4000 hours at 1330°F can be anticipated in an inert atmosphere containing 100 ppM oxygen. Subsequent work to improve anodic processing with respect to the elimination of defects at contact points and inside of holes was carried out. Finally, qualification specimens resembling the actual reflector parts were anodized and evaluated. (auth)

6752 (IITRI–578P29-5) RESEARCH ON ZIRCALOY BRAZE ALLOY DEVELOPMENT. Quarterly Report July 1, 1966–September 30, 1966. (IIT Research Inst., Chicago, Ill.). Oct. 17, 1966. Contract AT(11-1)-578. 12p. (EURAEC–1737). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The first series of candidate braze alloys was prepared for evaluation. Twenty-two Zr-base binary alloy systems, including fifty-seven compositions, will be subjected to a superheated water environment in the as-cast and brazed conditions. More advanced Zr-base alloys will generate from those compositions exhibiting superior corrosion and hydrogen-uptake resistance. (auth)

6753 (IS–1350) EFFECT OF OXYGEN CONTENT ON THE LIQUID METAL CORROSION OF MOLYBDENUM. Smith, Dale L.; Murphy, Glenn; Fisher, Ray W. (Ames Lab., Iowa). Aug. 1966. Contract W-7405-eng-82. 91p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effect of impurity oxygen on the liquid-metal corrosion of molybdenum by lead, cadmium, tin, and zinc has been determined experimentally. Static corrosion tests were conducted with electron-beam welded 0.75-in. OD by 0.035-in. wall by 2-in. long molybdenum capsules containing the four low-melting metals. The majority of the tests were conducted for 300 hours at temperatures of 700 or 800°C. The oxygen content of the liquid metals was varied from six to 10,000 parts per million. The mechanisms by which the oxygen may interact are discussed and the results of the experimental tests are explained in terms of these mechanisms. The oxygen in the lead–molybdenum system formed a lead molybdate ($PbMoO_4$) surface layer, which tended to protect the molybdenum from solution attack. Oxygen in the cadmium formed cadmium molybdate ($CdMoO_4$), which did not adhere to the surface and thus increased the corrosion slightly. Simple solution attack of molybdenum occurred with low-oxygen (8 ppM) tin; however, a compound boundary-layer formation was noted in the high-oxygen tests. The zinc diffused rapidly through the molybdenum wall leaving the capsules empty after 100 hours at 700°C. The presence of oxygen in the zinc appeared to decrease the diffusion rate of the zinc slightly. (auth)

6754 (NAA-SR–6311) THE SNAP 2 POWER CONVERSION SYSTEM. TOPICAL REPORT NO. 19. MERCURY MATERIALS EVALUATION AND SELECTION FY-1962. Nejedlik, James F. (Thompson Ramo Wooldridge Inc., Cleveland, Ohio. TRW Electromechanical Div.). Aug. 1962. Contract AT-11-1-GEN-8; Subcontract N-843-FS-101221. 117p. (TRW-ER-5024). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Atomics International, Canoga Park, Calif.

SNAP-2 is the designation for a 3-kW nuclear auxiliary power unit to be used in a satellite vehicle. The SNAP-2 system consists of a reactor heat source, a boiler, a condenser, a mercury Rankine engine, and an alternator. The corrosion and subsequent mass transfer resulting from the use of mercury as the thermodynamic working fluid are important considerations in the selection of materials for the SNAP-2 System. Consequently, corrosion and mass transfer behavior have been under study for the past four years. Results for fiscal 1962 are presented. (auth)

6755 (NAA-SR–6316) SNAP 2 POWER CONVERSION SYSTEM. MERCURY MATERIALS EVALUATION AND SELECTION GFY-1963. Topical Report No. 24. Nejedlik, James F. (Thompson Ramo Wooldrige Inc., Cleveland, Ohio. TRW Electromechanical Div.). Nov. 19, 1963. Contract AT-11-1-GEN-8; Subcontract N-843-FS-101221. 156p. (TRW-ER-5643). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Atomics International, Canoga Park, Calif.

Corrosion of the SNAP-2 system by the working fluid, mercury, results in two undesirable effects: (1) wall penetration and (2) mass transport of corrosion products. Judicious choice of materials can only be made with a knowledge of corrosion behavior. Furthermore, to make use of conventional materials of construction, corrosion product removal is desirable to reduce fouling tendencies of the power system. Consequently, corrosion, mass transfer, and corrosion product removal were investigated and the results are presented. (auth)

6756 (NAA-SR-6321) MERCURY RANKINE POWER CONVERSION PROGRAM. TOPICAL REPORT NO. 29. MERCURY MATERIALS EVALUATION AND SELECTION GFY 1964. Nejedlik, James F. (Thompson Ramo Wooldridge Inc., Cleveland, Ohio. TRW Electromechanical Div.). Nov. 1964. Contract AT-11-1-GEN-8; Subcontract N-843-FS-101221. 168p. (TRW-ER-6265). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Atomics International, Canoga Park, Calif.

Corrosion of the materials in the MRPC system by the working fluid, mercury, results in two undesirable effects: (1) wall penetration and (2) generation and mass transport of corrosion products. Consequently, corrosion, mass transfer, and corrosion product removal methods are being investigated. Test methods included glass and metal reflux capsules and thermal convection two-phase loops. Reflux capsule corrosion screening tests were made of several nickel-, cobalt-, and iron-base alloys at 400 to 900°F. Classifications were made as to feasibility for use of these materials in a mercury environment on the basis of weight change and penetration. Metal capsule tests at 800 to 1200°F indicated diffusion controlled corrosion for Haynes Alloy 25, PH15-7Mo, and Croloy 9M. Weight losses and penetrations generally ranged on the average about four-fold greater than corresponding glass reflux capsule results. A thermal convection two-phase Haynes Alloy 25/PH15-7Mo loop which duplicated an earlier test substantiated corrosion data obtained previously. This showed that corrosion obtained in loop tests is reproducible. Inhibition of corrosion in a Haynes Alloy 25 loop was shown to be feasible. This was accomplished by two methods: a titanium-magnesium pretreatment, and a titanium source in a cold leg. Thermal convection loop tests indicated that corrosion product separator techniques utilizing thermal diffusion, filter-getters and magnetic fields were effective methods of separation. No adverse effect of corrosion product separation on corrosion was observed. Materials corrosion test results indicate a one-year life capability for the present MRPC reference materials. (auth)

6757 (NYO-3477-8) MECHANISM OF EROSION OF SOLID METALS. Progress Report. Moore, Mark B. (Rutgers-The State Univ., New Brunswick, N. J. Bureau of Engineering Research). June 1966. Contract AT(30-1)-3477. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Three separate modes or phases of erosion have been identified, and tests have been made involving each of the phases. The rate of Phase A erosion has been identified with the energy of the eroding particles, and tests to date indicate that, at constant particle energy levels, variation in the particle momentum has no appreciable effect upon the rate of Phase A erosion. Tests are in progress to attempt to determine if similar relationships exist between particle energy, particle momentum, and the rates of Phase B erosion. Stepwise erosion has been identified as a metal flow phenomenon, involving simultaneous Phase A and Phase B types of action. The existence of stepwise erosion has been found to be dependent upon original contact angle, particle velocity, particle size, and possibly upon solids-to-air loading ratio. The projected study of single-particle trajectories has not yet yielded satisfactory results, due to poor performance of the single-particle gun. Redesign of the gun is now under way. (auth)

6758 (R-66SD3015) EVALUATION OF HIGH STRENGTH COLUMBIUM ALLOYS FOR ALKALI METAL CONTAINMENT. Final Report, July 25, 1962-December 15, 1964. Engel, L. B. Jr.; Frank, R. G. (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). Contract NAS 3-2140. 102p.

Corrosion testing of four reflux capsules, two AS-55 (Nb-base-W-Zr-C-Y), one Nb-1 Zr, and one D-43 (Nb-base-W-Zr-C), containing purified K was conducted at 2000°F for 10,000 hr under a vacuum of 10^{-8} to 10^{-9} torr. The condensing rate of the K in the capsules was ~37 ± 12 lb/hr/ft^2 at 2000°F. Overall only a small amount of corrosion, consisting primarily of staining and black dposits of Zr, the formation of Y compound believed to be Y_2O_3, and leaching of oxygen from the capsule material by the K, was observed. The amount of staining and black deposits was either reduced or eliminated by use of an improved K transfer system. Coalescence of the carbides in the grain boundaries apparently occurred in the AS-55 and D-43 alloys and stress-rupture testing of specimens machined from the capsule walls after the 10,000-hr exposure revealed a significant decrease in strength. Chemical analyses of samples obtained from the capsule walls revealed no significant mass transfer of C with either the AS-55 or D-43. (A.G.W.)

6759 (TID-7626(Pt.2)) NASA-AEC LIQUID METALS CORROSION MEETING, DECEMBER 14-15, 1961, BROOKHAVEN NATIONAL LABORATORY. (National Aeronautics and Space Administration, Washington, D. C. Atomic Energy Commission, Washington, D. C.). July 1962. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A summary is given of the information presented by representatives of ORNL and P&WA-CANEL at the meeting. The information concerns alkali metal compatibility and corrosion studies, and refractory metals, including Nb-1 Zr. (D.L.C.)

6760 CORROSION. Brasher, Dora M.; Britton, S. C.; Maylor, J. B.; Peace, W. M. Rep. Progr. Appl. Chem., 50: 620-30 (1965).

Recent developments are reviewed under the following headings: corrosion inhibitors; iron and steel; mechanisms of atmospheric corrosion; high nickel alloys; corrosion tests for nickel-chromium coatings; stress corrosion; and corrosion resistance of yttrium. (UK)

6761 SPECIAL PROBLEMS OF WATER CORROSION FOUND IN NUCLEAR INSTALLATIONS. Coriou, H. (CEN de Saclay, Gif-sur-Yvette, France). Corros. Anti-Corros., 14: 301-8(Oct.-Nov. 1966). (In French).

Nuclear energy problems led to the development of new metals or the use of classical materials under unusual conditions. The special corrosion problems resulting from this were studied. The complexity of the phenomena encountered is shown, and a certain number of examples are described. The problems encountered in the moving and storage of corrosion products in reactor circuits were examined. Finally, certain questions related to irradiated fuel treatment factories are reviewed. (auth)

6762 EPITAXIAL OXIDATION OF ZIRCONIUM AT VARIOUS TEMPERATURES. Vahldiek, F. W. (Air Force Materials Lab., Wright-Patterson AFB, Ohio). J. Less-Common Metals, 12: 19-28(1967).

Transmission electron microscopy on annealed Zr thin films revealed epitaxial oxidation to ZrO_2 at estimated beam temperatures between 100 and 170°C. Oxidation study using a hot stage at temperatures ranging from 200 to 700°C resulted in instantaneous oxidation to monoclinic ZrO_2. Direct observation of rhombohedrally shaped dislocations as possible nucleation points for epitaxial oxidation on the (0001) plane were detected using a cold-stage attachment at liquid-nitrogen temperatures of approximately -175°C. Zirconium hydride was definitely identified to be present in annealed Zr foils by electron diffraction. (auth)

6763 ALNIFLEX PROCESS FOR DISSOLVING ZIRCONIUM-URANIUM ALLOY IN 304L STAINLESS STEEL VESSELS. Carcciolo, V. P.; Rust, F. G. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Ind. Eng. Chem., Process Design Develop., 5: 364-8(Oct. 1966). (CONF-650902-7).

A process was developed for dissolution of spent Zr-U reactor fuel alloys in Type 304L stainless steel vessels. An example is given of the decomposition of irradiated Zircaloy-2-clad alloys with solutions of 2M HF, 1M HNO_3, 1M $Al(NO_3)_3$, and 0.1M $(NH_4)_2Cr_2O_7$, after autoclaving the elements for 2 days at 400°C in steam at 1500 psig. Increments of HF were routinely added during dissolution to maintain a Zr concentration of 0.05M. More than 99.5% of the fuel is dissolved at 70°C in 24 hours. Rate of corrosion of the Type 304L stainless steel averages 10 to 15 mils per year in the liquid phase and less than 1 mil per year in the vapor phase. (P.G.C.)

6764 ABSORPTION OF HYDROGEN IN POROUS BEDS OF ZIRCONIUM HYDRIDE. Lightner, Ralph G. (Martin Co., Baltimore); Duffey, Dick. Trans. Amer. Nucl. Soc., 9: 404(Oct.-Nov. 1966).

6765 BEHAVIOR OF 304- AND 316-TYPE STAINLESS STEELS IN HIGH CARBON SODIUM. Hiltz, Ralph H.; Andrews, Richard C. (MSA Research Corp., Evans City, Pa.). Trans. Amer. Nucl. Soc., 9: 426(Oct.-Nov. 1966).

6766 CORROSION BEHAVIOR OF ZIRCALOY-4: EVALUATION OF SURFACE CONDITIONS. Lowe, A. L. Jr.; Johnson, C. R. (Babcock and Wilcox Co., Lynchburg, Va.). Trans. Amer. Nucl. Soc., 9: 427-8(Oct.-Nov. 1966).

6767 CORROSION TESTING OF HIGH-STRENGTH ALUMINUM ALLOY FOR USE AS CLADDING MATERIAL ON REACTOR FUEL ELEMENTS. Gibson, G. W.; Zukor, M. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 9: 428-9(Oct.-Nov. 1966).

6768 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Walton, Gilbert Northcott (to United Kingdom Atomic Energy Authority). British Patent 1,047,333. Nov. 2, 1966. Filed June 10, 1963.

A method to reduce the corrosion in a water cooled reactor comprises the addition of 4 to 60 ppm of NH_3 to the cooling water. The NH_3 may be added continuously to the coolant in an amount calculated to be sufficient to replace any loss and may be effected

by the direct addition of NH_3, by the addition of a solution of NH_3 in water, or by the passage of a part or all of the coolant through an ammoniated ion exchange resin in an exchange column. (B.L.M.)

Preparation and Fabrication

Refer also to abstracts 6328, 7044, 7933, 8176, and 8177.

6769 (MCW-1514) ELECTROLYTIC URANIUM PROJECT: CELL OPERATION. Terminal Progress Report. Stevenson, J. W. (Maryland Univ., College Park. Inst. for Molecular Physics). Oct. 31, 1966. Contract W-14-108-eng-8. 91p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Pilot plant cell operations for the production of reactor grade U metal castings from UO_2 are described. Uranium oxide and fluoride are fed down the axial hole in the anode columns in the cell operation. The powders contact molten $BaF_2-LiF-UF_4$ electrolyte in the anode region. The UF_4 dissolves readily and the UO_2 perhaps less readily and certainly less extensively (2 to 4% maximum). Carbon monoxide and CF_4 gases are evolved at the anodes and metal is deposited on the cathodic crucible. The metal is withdrawn periodically via a vacuum lift tube into suitably prepared molds. Operating procedures, casting equipment, and centrifugal casting tests are described. (P.C.H.)

6770 (N-66-30489) ALLOY IONIZER FABRICATION. Summary Report. Turk, R. R.; McKee, W. E. (Hughes Research Labs., Malibu, Calif.). May 1966. Contract NAS-3-6272. 176p. CFSTI $3.00 cy, $0.65 mn.

Fabrication of porous refractory ionizer material from prealloyed, spherical powders of narrow size range was investigated. Alloy powders used were 50 Ir-50W, 5 Re-95W, and 25 Re-75W (pure iridium was also included). Pellets from mixtures of elemental powders of the same elements were prepared in high density form. Fabrication techniques studied included warm pressing, joining methods, and surface treatment to keep pores open. (auth)

6771 SPARK EROSION FABRICATION OF SINGLE CRYSTAL TUNGSTEN RIBBON FILAMENTS. Reynolds, F. L. (Univ. of California, Berkeley). Rev. Sci. Instrum., 37: 1730-1(Dec. 1966). (UCRL-16903).

After a number of attempts to cut tungsten by various techniques, it was found that the entire process for fabrication of oriented tungsten filaments can be done very satisfactorily on spark erosion equipment. The entire process using single crystal tungsten stock is described in detail. (M.H.R.)

6772 PENETRATION OF SOLIDS BY HIGH-POWER-DENSITY ELECTRON BEAMS. Passoja, Dann E. (Rensselaer Polytechnic Inst., Troy, N. Y.). Brit. Weld. J., 14: 13-16(Jan. 1967).

Dimensional analysis is used to determine the relationship between the depth of penetration Z and other independent variables normally considered in electron beam welding. The relationship between Z and the variables of beam diameter, D_B, power input, Q'_B, welding velocity, v_w, and intrinsic thermal-material properties, Q_i, is shown to be $Z = D_B (Q'_B/D_B^2 v_w Q_i)^m$. The value of m was determined experimentally. The penetration versus welding velocity and penetration versus electron beam current curves were then calculated for several materials. (auth)

6773 THE USE OF HIGH-TEMPERATURE THERMOMECHANICAL TREATMENT IN THE MANUFACTURE OF EXTRUDED BT-15 TITANIUM ALLOY TUBES. Kishkin, S. T.; Glazunov, S. G.; Khorev, A. I.; Rubin, Yu. L.; Shilina, E. M. Izv. Akad. Nauk SSSR, Metal., No. 3, 125-9(1966). (In Russian).

Vacuum-arc melted ingots of VT15 Ti-base alloy (2.99 to 3.05% Al, 10.7 to 11.1% Cr) were conditioned by machining and extruded into bars 187 mm in dia. The bars were cut into tube billets which were pierced, conditioned, and extruded at 950 to 1150°C into tubes with an outside dia of 110 mm and a wall thickness of 10 mm. Part of the extruded tubes were air cooled and then subjected to annealing at 800°C followed by water quenching and another part was subjected to high temperature thermomechanical treatment (HTMT), i.e., were water quenched immediately after extrusion. Both tube lots were then double aged at 450°C for 25 or 50 hr and at 560°C for 15 min. The tubes which underwent HTMT had considerably better mechanical properties. (J.R.D.)

6774 HIGH-PURITY HELIUM ATMOSPHERE FOR PLUTONIUM RESEARCH. Ludlow, J. O.; Coleman, L. F.; Nelson, P. A.; Schraidt, J. H.; Slawecki, M. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 614-15(Oct.-Nov. 1966).

6775 REMOTELY OPERATED EQUIPMENT FOR FABRICATING HFIR TARGET ELEMENTS. Lotts, A. L.; Preston, M. K.; Sease, J. D.; Van Cleve, J. E. Jr. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 627-8(Oct.-Nov. 1966).

6776 PRACTICAL FUNDAMENTALS OF ATMOSPHERE BRAZING OF NICKEL ALLOYS. Kaufman, S. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 403-4(Oct.-Nov. 1966).

6777 UO_2-ThO_2 FUEL-ROD CLADDING DEVELOPMENT. Fischer, R. L. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 430-1(Oct.-Nov. 1966).

6778 PREPARATION OF NUCLEAR TARGETS ON THIN BASES. MEASUREMENT OF MASS DEPOSITED PER UNIT SURFACE. Jouanigot, J.; Bardolle, G.; Cabe, J.; Chretien, J. F.; Laurat, M. (CEA, Montrouge, France). Nucl. Instrum. Methods, 47: 105-8(Jan. 1967). (In French).

A procedure of fabrication of targets with supports and deposits having thicknesses of some tens of $\mu g/cm^2$ is presented. The masses of the deposits, obtained with the quartz method (accuracy 2%) have been confirmed by a Rutherford scattering study on the same deposits. The two methods showed a satisfactory agreement. (auth)

6779 PREPARATION OF ^{226}Ra TARGET. Selitskii, Yu. A.; Solov'ev, S. M. Prib. Tekh. Eksp., No. 4, 196-7(July-Aug. 1966). (In Russian).

Preparation of radium target by $RaCl_2$ evaporation on a thin metallic film in a vacuum is described. Under favorable conditions, layers of ~30 $\mu g/cm^2$ were obtained. (tr-auth)

6780 PREPARATION OF Mo AND Re FOILS FOR NUCLEAR STUDIES. Klyucharev, A. P.; Karev, V. N.; Nikolaichuk, A. D.; Nazarova, T. S.; Medyanik, V. N.; Rozen, A. A. (Inst. of Physics and Technology, Kharkov). Prib. Tekh. Eksp., No. 4, 197-8(July-Aug. 1966). (In Russian).

The preparation of Mo and Re foils (1 to 7 μ thick) by means of thermal dissociation of their pentachlorides is described. The thermal dissociation is achieved in a vacuum chamber at 850 to 900°C temperature using a copper backing. The foils obtained had a five crystalline structure free from copper impurities. (tr-auth)

6781 ZHAROSTOIKIE POKRYTIYA. TRUDY SEMINARA PO ZHAROSTROIKIM POKRYTIYAM (LENINGRAD, 26-28 MAYA 1964). (Heat-Resistant Coatings. Bulletin of the Seminar on Heat Resisting Coatings (Leningrad, May 26-28, 1964)). Toropov, N. A.; Ivanov, V. E.; Appen, A. A. (eds.). Leningrad-Moscow, Izdatelstvo Nauka, 1965. 235p.

Twenty-four articles are included on the physicochemical properties, kinetics, and production of heat-resistant inorganic coatings. Coating diffusion to the surface, thermal tension, silicification of Mo, Cr-Mo coatings, galvanized Mo-W coatings, vitreous-metallic-ceramic coatings, enamel coatings, and gas-flame methods of coating are discussed as well as thermal conductivity and radiative properties of gas-flame ceramic coatings. (R.V.J.)

6782 PROCESS FOR WELDING NICKEL TO NIOBIUM. Wohlberg, Cornel; Markham, Jack R. (to U. S. Atomic Energy Commission). U. S. Patent 3,290,773. Dec. 13, 1966.

A process for welding Ni to Nb using wrought Monel as a welding filler rod is described. The Monel is composed of 65 to 69 wt % Ni and 29 to 32 wt % Cu. (AEC)

6783 BRAZING ALLOYS FOR REFRACTORY METALS. Gilliland, R. G. (to U. S. Atomic Energy Commission). U. S. Patent 3,293,741. Dec. 27, 1966.

A patent is described relating to a brazing alloy for joining Ta, W, Nb, Mo, and alloys of these metals to themselves and to one another. This brazing alloy consists of 30 to 50 wt % V, 30 to 50 wt % Ti, and 20 to 30 wt % Ta. (AEC)

6784 BRAZING ALLOYS FOR TUNGSTEN AND MOLYBDENUM. Marshall, J. C.; Smith, H. G. (to U. S. Atomic Energy Commission). U. S. Patent 3,292,255. Dec. 20, 1966.

A brazing alloy for joining Mo, W, and their alloys at 1950 to 2500°C is described. The alloy consists of 40 to 87 wt % Mo, 5 to 40 wt % Ru, and 8 to 55 wt % Re. (AEC)

6785 STEAM CORROSION-RESISTANT IRON-CHROMIUM-ALUMINUM-YTTRIUM ALLOYS AND PROCESS FOR MAKING SAME. Wukusick, C. S. (to U. S. Atomic Energy Commission). U. S. Patent 3,293,007. Dec. 20, 1966.

A dispersion-strengthened Fe-Cr-Al-Y alloy, consisting of an Fe-Cr-Al matrix and a finely dispersed phase of Fe and Y is described. The particles of the dispersed phase have a maximum dia no greater than 5μ. The preferred method for making such an alloy is by atomization of a molten composition to form an alloy powder having the described metallurgical structure and Y-containing dispersed phase. (AEC)

6786 REFRACTORY METAL COMPOSITE. Larsen, Earl I. (to P. R. Mallory and Co.). U. S. Patent 3,272,603. Sept. 13, 1966. Filed Jan. 23, 1964.

Beneficial effects of the addition of small amounts of Y to composite materials and compounds used to make welding electrodes and electric contacts are described. Specifically mentioned is a Cu–Y–refractory metal composition in which the refractory may be Mo, W, or the carbides of those metals. Articles may be made by infiltration of the porous refractory metal, or carbide skeleton, by a Cu–Y alloy, or by compacting and sintering a mix of powdered Cu–Y alloy and powdered refractory metal. The addition of Y does not depress the electric conductivity of the Cu, but substantially increases resistance to oxidation. (P.G.C.)

6787 TITANIUM PRETREATMENT FOR PROTECTIVE COATING OF REFRACTORY ALLOYS. Jefferys, Richard Alexander (to TRW Inc.). U. S. Patent 3,268,306. Aug. 23, 1966. Filed Mar. 28, 1962.

A five-step process is described for coating a solid base refractory metal or alloy with other oxidation resistant metals by a solid-vapor interface alloying reaction. Examples given pertain especially to Cr and Ti alloys although other metals of the fourth to sixth group of the periodic system of elements are also amenable to this treatment. The method is stated to prevent cracks and pin holes caused by thermal or mechanical stresses in metallic coatings produced by other methods. (P.G.C.)

6788 NICKEL-BASE ALLOY CONTAINING Mo–W–Al–Cr–Ta–Zr–C–Nb–B. Freche, John C.; Waters, William J. (to National Aeronautics and Space Administration). U. S. Patent 3,276,866. Oct. 4, 1966. Filed Apr. 14, 1964.

An improved Ni-base alloy having high load carrying capacity at high temperatures (ca 1900°F), resistance to oxidation, and sufficient ductility to facilitate fabrication into sheets, was developed. The alloy was prepared by melting in stabilized zirconia crucibles, under a protective cover of Ar, and cast in investment molds under normal atmospheric conditions, thus eliminating the closely controlled vacuum techniques ordinarily used. Vacuum melting techniques, however, may be used to reduce gas content in the alloy, and to improve cleanliness of the melt. (P.B.C.)

6789 METHOD OF PRODUCING HOMOGENEOUS ALLOYS CONTAINING REFRACTORY METALS. Vordahl, Milton B. (to Crucible Steel Co. of America). U. S. Patent 3,269,825. Aug. 30, 1966. Filed June 18, 1963.

A method for making homogeneous alloys containing metals with such dissimilar melting points as Mo, Nb, Ti, and Zr, comprises mixing Mo and Sn powders, rolling the mixture into flakes, and adding the alloy powder flakes to granules of one or more of the refractory metals having a melting point below that of Mo. The blended materials are pressed into briquettes and melted into ingots by the vacuum arc process. The ingots are again melted by the consumable electrode vacuum arc method into a water-cooled Cu crucible. The ingots, so produced, show a uniformity of structure with elimination of deleterious inclusions, particularly unmelted Mo, which are present in alloys of similar composition prepared by other methods. These alloys can be hot rolled at temperatures above 1200°F with lower roll pressures than other Ti alloys, and in small thicknesses may be cold rolled into thin sheets. They may be solution treated to develop other properties. (P.G.C.)

6790 METHOD OF CONTINUOUS PRODUCTION OF HIGH PURITY BERYLLIUM METAL. Nakamura, Takao (to NGK Insulators, Ltd.). U. S. Patent 3,278,402. Oct. 11, 1966. Priority date Aug. 17, 1961, Japan.

A continuous process is described for the production of high-purity Be metal from $BeCl_2$ and NaCl. Electrolysis of the molten salts is conducted in Ni cells heated externally at 300 to 400°C. Be flake, deposited on Ni cathodes, is scraped off, collected in porous Ni receivers, and removed at intervals with no interruption of the process. Be content of the bath is maintained throughout the process by stoichiometric additions. Be produced by this method is of higher purity than that produced by electrolysis of fused $BeCl_2$, or by Mg reduction of BeF_2. (P.G.C.)

6791 MOLYBDENUM-BASE ALLOY. Chan, Winston H. (to General Electric Co.). U. S. Patent 3,275,434. Sept. 27, 1966. Filed Apr. 13, 1964.

Precipitation-hardenable Mo alloys, containing Ti, Zr, and C, were developed which combined high temperature strength and low temperature ductility. Optimum contents and proportions of Ti, Zr, and C are specified to develop desired properties and to avoid formation of undesirable Mo_2C. The alloys are not deleteriously susceptible to aging defects during use at high temperatures. (P.G.C.)

6792 ELECTROFORMING OF BERYLLIUM. Strohmeier, Walter (to Ethyl Corp.). U. S. Patent 3,278,400. Oct. 11, 1966. Priority date Nov. 14, 1961, Germany.

A method is described for depositing adherent, polishable coatings of Be metal on substrates previously considered unsuitable. The process comprises electrodeposition of the metal from organic Be compounds complexed with alkali metal salts, preferably from the group having atomic numbers 19 through 55. Deposition is conducted at a relatively low temperature and coatings may be put on materials such as plastics or paper which are not heat resistant. (P.G.C.)

6793 METHODS OF PREPARING URANIUM BY MAGNESIOTHERMY. Delange, Maurice; Huet, Henri; Vertes, Paul (to Commissariat a l'Energie Atomique). U. S. Patent 3,279,913. Oct. 18, 1966. Priority date May 30, 1962, France.

A method and apparatus are described for the manufacture of metallic uranium from UF_4 having a specific gravity of about 1.65 in which the UF_4 is crushed into a powder; the powder is degassed, mixed with magnesium, and charged into a crucible and packed; and the crucible and its contents are heated to start the exothermic reaction. The grain size of the powder should be lower than 200 μ. The degassing operation is carried out at a temperature of about 250°C to reduce the amount of occluded gas to less than 0.01%. (B.L.M.)

Properties Evaluations

Refer also to abstract 6159, 6773, 6788, 6789, 6791, 7371, 7885, and 7984.

6794 (ACF–20) MECHANICAL PROPERTIES IN 5 PERCENT ALUMINUM–2.5 PERCENT TIN TITANIUM ALLOY. Walter, E. C.; Wetzler, D. L. (ACF Industries, Inc., Albuquerque, N. Mex.). Sept. 29, 1966. Contract AT(29-1)-1352. 51p. (ACF–412-311). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data are given on transformation-process effects on the mechanical properties of Ti alloys containing 5% Al and 2.5% Sn. These all-alpha type alloys have close-packed-hexagonal structure, and begin transformation to body-centered-cubic beta-type at 1700° ± 25°F, completing transformation at 1900°F. Mechanical properties, except hardness which changed little, vary with inherent microstructure, but mechanical properties and characteristics of two-inch bar stock compare favorably with forgings of similar material. (P.G.C.)

6795 (AD–641262) METALLURGICAL CHARACTERISTICS OF HIGH STRENGTH STRUCTURAL MATERIALS. Quarterly Report No. 10, December 1965–March 1966. Goode, R. J.; Huber, R. W.; Judy, R. W. Jr.; Howe, D. G.; Puzak, P. P.; Lloyd, K. B.; Crooker, T. W.; Morey, R. E.; Lange, E. A.; Freed, C. N. (Naval Research Lab., Washington, D. C.). Apr. 1966. 104p. (NRL–6454). CFSTI $3.00 cy, $0.65 mn.

Research studies on which progress is reported include fracture-toughness studies on expected normal-production 12%-Ni maraging and 9Ni–4Co–0.25C steels, a variety of circular-rolled and conventionally rolled titanium alloys, and aluminum alloys using standard engineering, newly developed, and linear elastic fracture mechanics-type fracture-toughness tests. Preliminary correlations of K_{Ic} with drop-weight tear test energy for a variety of titanium alloys are presented. Low-cycle fatigue crack propagation in 12%-Ni maraging steels in air and salt water is described and compared to the behavior of other steels. Crack initiation versus propagation failure criteria for low-cycle fatigue in air and in aqueous environments is presented for HY-80 and 5Ni–Cr–Mo–V steels and 12%-Ni maraging steels. The stress-corrosion-cracking resistance of a variety of titanium alloys and several aluminum alloys has been determined using a cantilever-bend test; comparison of results obtained in the laboratory and in natural seawater at Key West is presented for a Ti–7Al–2Nb–1Ta alloy. (auth)

6796 (AERE-Bib–151) COMPENDIUM OF REFERENCES TO STUDIES OF THE PROPERTIES OF LIQUID METAL BINARY SYSTEMS WHICH RELATE TO THEIR STRUCTURE. Mott, B. W.; Downey, M. E.; Cumming, P. A. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1966. 58p. Dep. BIS $1.60. HMSO 8s. 0d.

The references are compiled in alphabetical order of chemical symbol for the components of each system. Papers dealing solely with experimental work on thermodynamic properties were omitted as these are available elsewhere. (M.H.R.)

6797 (COO–1477–6) DEVELOPMENT OF TEST PROCEDURES. FRACTURE TOUGHNESS OF REACTOR PRESSURE VESSEL STEELS. Progress Report, August 1, 1966–October 31, 1966. Ripling, E. J.; Crosley, P. B. (Materials Research Lab., Inc., Richton Park, Ill.). Nov. 30, 1966. Contract AT(11-1)-1477. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Plane-strain, room-temperature, toughness values of A302-B, which appear to be valid, have been measured on reasonable sized

specimens. The toughness decreased, and approached the value for crack arrest toughness, as the loading rate was increased. (auth)

6798 (EURAEC-1738) SPECIFIC ZIRCONIUM ALLOY DESIGN PROGRAM. Quarterly Report No. 14. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct. 7, 1966. Contract AT(04-3)-189. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

A Zr + 2.0 at. % Cr + 0.16 at. % Fe alloy is being evaluated as water reactor fuel cladding. Three different laboratory melts have been fabricated to sheet by processes established from the physical metallurgy studies and statistically designed fabrication experiments. The corrosion rates of the laboratory material were established by corrosion exposures in refreshed oxygenated steam. A full-scale tubing fabrication process has been established. The second tubing batch processing is complete through extrusion and the first two tube reductions are complete on one-half of the order. Rod for fuel end caps has been received. (M.H.R.)

6799 (IS-T-124) SPECIFIC HEAT OF FCC AND D-HCP LANTHANUM FROM 1.0 TO 10.0 DEG K. Johnson, David Lee (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 77p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The specific heat of fcc and d-hcp La was measured in the temperature range from 1.0 to 10.0°K in both the superconducting and normal states. Values of the electronic specific heat coefficient γ and the Debye temperature θ_D were determined for both phases from the normal state measurements. The Debye temperature was found to be 140 ± 2°K for the fcc phase and 152 ± 1.5°K for the d-hcp phase. Both were constant below about 3°K in agreement with lattice theory. The electronic specific heat coefficients were 11.5 ± 0.25 (mj/mole°K) and 9.40 ± 0.1 (mj/mole°K) for the fcc and d-hcp phases, respectively. The superconducting state data were analyzed to determine whether either phase of La deviates significantly from the law of corresponding states and to compare both phases with the BCS theory and with other superconductors. Critical fields of both phases deduced from these measurements showed good agreement with the law of corresponding states and deviated from the BCS theory in a manner consistent with the measured values of T_C/θ_D. (0.042 for fcc La and 0.032 for d-hcp La). Because this ratio for both phases is comparable to the corresponding ratio for Nb (0.033), a comparison was made with the Nb results of Leupold and Boorse. This comparison showed remarkable similarity between the two metals as the thermodynamic properties of both could be quite well described by a simple scaling of the temperature dependent BCS energy gap function by a factor of approximately (3.7/3.53). (auth)

6800 (LA-3544) ON RELATING THE FLOW STRESS OF ALUMINUM TO STRAIN, STRAIN RATE, AND TEMPERATURE. Hockett, John E. (Los Alamos Scientific Lab., N. Mex.). July 21, 1966. Contract W-7405-eng-36. 60p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The need for basic information about the relationship between resistance to deformation (flow stress), temperature, strain, and strain rate, for the solution of metal-forming problems, is pointed out. Early attempts to satisfy the need are mentioned. A brief description of a machine called a Cam Plastometer is given, followed by some typical results obtained by testing commercially pure Al in the machine. Next, a program of testing Al in compression over a wide range of constant true-strain rates (0.1 to >200 sec^{-1}) and a moderately broad range of temperatures (223° to 673°K) is described. The results of this program are presented in the form of true-stress vs true-strain curves. The data in these curves are presented in the form of relationships between true stress and true-strain rate in semilogarithmic and log-log form, as functions of temperatures—for several true strains. Finally, true stress is displayed as a function of log true-strain rate and absolute temperature for four different true strains. (auth)

6801 (LA-3554) SEALED-TUBE DISSOLUTION METHOD WITH APPLICATIONS TO PLUTONIUM-CONTAINING MATERIALS. Metz, Charles F.; Waterbury, Glenn R. (Los Alamos Scientific Lab., N. Mex.). July 1, 1966. Contract W-7405-eng-36. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Experience with a previously known technique for dissolving highly refractory materials is described. The technique was found to have wide application. It consisted of sealing the sample with HCl and an oxidant in a heavy-walled SiO_2 tube and heating to a suitable temperature, usually between 100 and 350°C. The sealed SiO_2 tube is placed in a steel shell to which solid CO_2 is added to compensate for the high internal pressure generated in the tube. Application of this dissolution method to refractory Pu-containing materials is described in detail. (auth)

6802 (N-66-30400) INVESTIGATION OF LONG-TERM EXPOSURE EFFECTS UNDER STRESS ON SUPERSONIC TRANSPORT STRUCTURAL ALLOYS. Martin, George (North American Aviation, Inc., Los Angeles, Calif.). [1966]. Contract NASw-921. 111p. (NASA-CR-76151; NA-65-24). CFSTI $3.00 cy, $0.65 mn.

The first two phases of a 30,000-hour exposure test are reported. Six materials—two Ti alloys, two PH steels, and two superalloys—were tested under stress in five environmental conditions comprising combinations of salt and braze coatings and constant and cyclic exposure at 650°F. Braze-coated Ti alloys, salt-coated Ti 8Al-1V-1Mo alloy, and cyclically exposed AM 350 steel were the only alloys subject to stress-corrosion failure within the 20,000-hour exposure covered. In this period relative phase changes occurred in the Ti alloys without significant mechanical property changes and aging reactions occurred in both steels and the superalloys with appropriate mechanical property changes. A hypothesis for corrosion reactions on titanium alloys in salt environments was developed. (auth)

6803 (N-66-32184) CRACK INITIATION IN METALLIC MATERIALS. Quarterly Report, June 1-November 30, 1965. Weiss, V.; Krause, G.; Chave, C. Jr.; Marchetto, G. (Syracuse Univ. Research Inst., N. Y. Dept. of Chemical Engineering and Metallurgy). Jan. 1966. Contract NOw-65-0355d. 20p. (MET-E-1289-1566P2-3). CFSTI $3.00 cy, $0.65 mn.

Progress is reported on the development of an acoustic detection method for determining crack initiation and propagation in metallic materials. Since the previous pickup arrangement seemed insufficient, a new compensation method for acoustic detection was used, which has a good signal to noise ratio and directly gives an acoustic signal versus load diagram on the screen of a storage oscilloscope. This recording system is described in detail and examples of typical first fracture-sound records are discussed. The measuring setup was tested in connection with a vacuum environment chamber which is used to standardize different specimens before changing the environment. (STAR)

6804 (USBM-RC-1264) QUARTERLY METALLURGY PROGRESS REPORT NO. 32, JULY 1-SEPTEMBER 30, 1966. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Contract AT(11-1)-599. 40p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on high melting point carbides, Th alloy systems, UC-UN-UO system, and W-Re-Mo alloy development. Hot tensile, hot hardness, air-oxidation resistance, and thermal-expansion data were obtained for carbides such as HfC-C, TaC-C, NbC-C, and ZrC-C castings. A fracture study was made on Th-ThO_2 tensile samples by visual, electron microprobe, and electron microscope techniques. No bonding was noted between the metal and the metal oxide particles. The phase relations in the monocarbide region of the ternary system U-C-O at 1,700°C were evaluated and a study completed of the relation between composition and both lattice parameters and decomposition pressure of the uranium oxycarbide solid solutions. A leaching test was made on impact pulverized W-Re-Mo alloy scrap. Bend tests were also made on W-25 Re sheet. (P.C.H.)

6805 (WANL-PR-(Q)-010) DEVELOPMENT OF DISPERSION STRENGTHENED TANTALUM BASE ALLOY. Quarterly Progress Report No. 9, November 20, 1965-February 20, 1966. Buckman, R. W. Jr.; Goodspeed, R. C. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Contract NAS 3-2542. 54p. (NASA-CR-72020).

Development of dispersion-strengthened Ta-base alloys for use in advanced space power systems continued with the completion of a study of the effect of welding, aging, and oxygen contamination on the ductile-brittle transition of six alloys. The alloys evaluated included carbide-, nitride-, and carbonitride-strengthened types, as well as two solid solution alloys. Further processing and more detailed evaluation of alloy ASTAR-811C (Ta-8W-1Re-0.7Hf-0.025C), a fabricable, creep-resistant composition, was also carried out. Preliminary test results indicate that a carbonitride-strengthened composition was resistant to Li corrosion at 2000°F. (auth)

6806 THERMAL CONDUCTIVITY OF MOLYBDENUM AT ELEVATED TEMPERATURES: INFLUENCE OF GRAIN SIZE AND IMPURITIES. Jun, C. K.; Hoch, Michael (Univ. of Cincinnati). pp IV.A.1-14 of Proceedings of the 4th Conference on Thermal Conductivity. San Francisco, U. S. Naval Radiological Defense Lab., 1964.

The thermal conductivity and total emittance of various Mo samples were measured between 1500 and 2200°K. The thermal con-

ductivity of two samples prepared by arc melting differed by 20% the coarser grained material had the higher conductivity. Samples prepared by powder metallurgical techniques, with the smallest grain size and largest concentration of impurities, had the lowest thermal conductivity. (auth)

6807 TWINNING AND CLEAVAGE FRACTURE IN MOLYBDENUM SINGLE CRYSTALS. Guiu, F. (Imperial Coll. of Science and Tech., London). J. Less-Common Metals, 12: 77-8(1967).

In an investigation of the orientation dependence of the mechanical properties of Mo single crystals, twinning and cleavage fracture occurred sometimes in specimens of rectangular cross section stressed in the [011] direction at 77°K. Twin traces on a $(3\bar{1}1)$ plane of a specimen that twinned and fractured just when the onset of the nonlinear region in the load elongation curve could be detected are discussed. The twins intersect along the $[31\bar{1}]$ direction on the (011) plane and are of the noncrossing type. (M.C.G.)

6808 THE ELECTRICAL RESISTIVITY OF TECHNETIUM FROM 8.0 DEG TO 1700 DEG K. Koch, C. C.; Love, G. R. (Oak Ridge National Lab., Tenn.). J. Less-Common Metals, 12: 29-35(1967). (ORNL-P-2294).

The electric resistivity of arc-melted ^{99}Tc metal was determined from its superconducting transition temperature (7.5°K) to 1700°K. Above 77°K, the resistivity can be described by, $\rho(\mu\Omega\text{-cm}) = -3.191 + 7.844 \times 10^{-2}T - 2.816 \times 10^{-5}T^2 + 4.038 \times 10^{-9}T^3$ to an accuracy greater than the nominal error in the data (±3 to 4%). These electric resistivity data made possible an analysis of available thermal conductivity data and the calculation of a Debye temperature for ^{99}Tc of 411°K. (auth)

6809 INFLUENCE OF ATMOSPHERIC NITROGEN ON THE CREEP PROPERTIES OF CHROMIUM–TANTALUM ALLOYS. Wilms, G. R.; Ryan, N. E. (Australian Defence Scientific Service, Melbourne). J. Less-Common Metals, 12: 11-18 (1967).

Tensile creep tests were carried out on Cr–2% Ta–0.1% Ti–0.5% Si and Cr–2% Ta–0.05% B alloys both in air and in Ar atmospheres, to study the effect of N_2 contamination on creep properties. Alloys tested in air showed superior creep strength in comparison with those tested in Ar; the difference in creep resistance was attributed to the internal precipitation of a complex Cr–Ta nitride. There were also differences in fracture behavior, and alloys tested in air were considerably less ductile than those tested in Ar. Attention is directed to the existence of a specimen-size effect in the case of creep tests done in air. (auth)

6810 SRL REMOTE METALLOGRAPHY FACILITY: ADMINISTRATION AND OPERATION. Cook, P. L. (E. I. du Pont de Nemours, Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 9: 616 (Oct.-Nov. 1966).

6811 THE PLANE-STRAIN FRACTURE TOUGHNESS OF ZIRCALOY-2 AS INFLUENCED BY COLD WORK AND THERMAL TREATMENTS. Hoagland, R. G.; Rowe, R. G. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 426-7 (Oct.-Nov. 1966).

6812 BEHAVIOR OF FUEL CLADDINGS UNDER LOAD IN HIGH-TEMPERATURE SODIUM. Susskind, H.; Becker, W. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 426(Oct.-Nov. 1966).

6813 APPLICATION OF RARE METALS IN THE CHEMICAL INDUSTRY. Szantay, Balazs. Magyar Kem. Lapja, 21: 518-24(Oct. 1966). (In Hungarian).

Applications of the metals Ti, Zr, Hf, Ta, Nb, and Mo, and their alloys are discussed. Physical constants, mechanical strength, corrosion resistance, and relevant literature for further information are listed. (auth)

6814 DIFFUSION OF MOLYBDENUM IN COPPER BY MEASURING THE THERMAL EMF. Nikolaeva, V. N. (Inst. of Steel and Alloys, Moscow). Izv. Vyssh. Ucheb. Zaved., Tsvetn. Met., No. 3, 132-3(1966). (In Russian).

Well-deoxidized, metallographically pure copper was used to investigate the diffusion of Mo in Cu in bimetal at 950 to 980°C. The specimens were annealed in a vacuum furnace. Cylindrical specimens 20 mm long were heated in open ampules under a layer of dry pure Mo shavings 100 mm thick. Holding time was 100 and 200 hr. Diffusion of the Mo in the Cu was studied metallographically and by measuring the microhardness and microthermal emf. The metallographic examination showed that the dotted structure characteristic of diffusion layers appeared near the surface, the dots being arranged frequently as accumulations, possibly along the sub-boundaries. A strongly etched black band was sometimes observed within the layer. An interesting feature was that the dotted structure was not seen without etching and, furthermore, was not demonstrated by any etchant that elicited the Cu structure. Measurement of the microhardness and microthermal emf showed that diffusion of Mo in Cu occurred to a greater depth than of the layer with the special structure. A maximum of the microthermal emf close to the boundary of the layer with the special microstructure and a further smooth transition to that of pure Cu was observed in all cases. The maximum depth of the layer was 0.19 mm for a holding time of 200 hr and from 0 to 0.09 mm for 100-hr holding. The magnitude of the thermal emf proved to be a quite sensitive characteristic of the change of the composition of the solid solution and is a convenient property for a fast study for numerous points in a layer. This method can also be used for determining the coefficients of diffusion after appropriate standard specimens with a known concentration of the diffusing element are fabricated. (ATD)

6815 CREEP AND TENSILE PROPERTIES OF HEAVILY DRAWN TUNGSTEN WIRE. Harris, B.; Ellison, E. G. (Pratt and Whitney Aircraft, North Haven, Conn.). Trans. Amer. Soc. Metals, 59: 744-54(1966).

A vacuum testing machine is described, which can be used to determine the mechanical properties of very fine wires at temperatures up to 2500°F. It was shown that the tensile creep strengths of drawn W wires are considerably higher than those of recrystallized bulk W in the temperature range studied. Conventional creep strain vs time curves for W wires exhibited fracture strains of up to 6% at 2000 and 2500°F, although at 1200 and 1500°F the strains were only about 1%. Recrystallization during creep tests was first noted at 2500°F. At this temperature the W appeared to recrystallize before the W – 1% ThO_2 but later than the W – 3% Re. For these materials in the conditions supplied by the manufacturers, W was stronger in creep than either W – 1% ThO_2 or W – 3% Re. However, if these results are normalized on the basis of their room-temperature yield strengths, then the thoriated alloy would show an advantage at elevated temperatures. (auth)

6816 ELECTRICAL RESISTIVITY OF α URANIUM CRYSTALS IN THE TEMPERATURE RANGE 67 TO 293°K. Raetskii, V. M. (NIIAR, Melekess, USSR). J. Nucl. Mater., 21: 105-8 (1966).

The electrical resistivity of α–U pseudo-monocrystals was measured by $\beta \rightarrow \alpha$ phase transformation. Measurements were performed by the potentiometric method from 67 to 293°K. (D.H.M.)

6817 ELECTRICAL RESISTANCE OF IRRADIATED α URANIUM CRYSTALS. Raetskii, V. M. (NIIAR, Melekess, USSR). J. Nucl. Mater., 21: 109-11(1966).

The electrical resistance of α–U pseudo-single crystals, irradiated in the SM-2 reactor by a dose of 7×10^{18} neutrons/cm^2 (thermal), was measured. A potentiometric method was used to measure the electrical resistance at liquid N_2 temperature and at 20°C. The difference $\Delta\rho = \rho - \rho_0$ between the electrical resistance of the same crystal before (ρ_0) and after (ρ) radiation was plotted against the direction of the principal crystallographic planes of the U lattice. At –196°C $\Delta\rho$ was positive and increased with the deviation from the principal directions in all three planes. At 20°C the dependence of $\Delta\rho$ on the direction was stronger. Near the principal directions the increase of electrical resistance was negative; however, with the deviation from the principal directions it became positive and approached the values obtained at –196°C and the difference between the values of $\Delta\rho$ at –196 and 20°C decreased with the deviation from the principal directions. The decrease of $\Delta\rho$ (–196°C) and the increased dependence of $\Delta\rho$ on direction in the three principal crystallographic planes as the temperature decreased indicated that irradiation resulted in both a decrease of the total resistance and in the growth of the anisotropy of its temperature-dependent part. (D.H.M.)

6818 EFFECT OF VACUUM ON THE CREEP OF BETA ZIRCONIUM AT HIGH TEMPERATURE. Abramyan, E. A.; Ivanov, L. I.; Kudryavtsev, N. S.; Yanushkevich, V. A. (Baikov Inst. of Metallurgy, Moscow). Fiz.-Khim. Mekh. Mater., 2: 422-5(1966). (In Russian).

The effect of vacuum (10^{-6} to 10^{-1} mm Hg) on the creep rate and rupture life of Zr at 1100 to 1300°C and under stresses of 5 to 30 kg/mm^2 was investigated. In a vacuum of about 10^{-5} at 1200°C, the creep rate was constant for more than 10 hr. The specimens did not fail and the material was very ductile. With the pressure in the vacuum chamber increased to 10^{-4} mm Hg, the creep rate was found to decrease continuously with time. Simultaneously with a drop of ductility, the rupture life decreased and the failure occurred in a very short time. The negative effect of higher pressure on rupture life and ductility became more intensive with increasing temperature and stress. (ATD)

6819 INVESTIGATION OF ALLOYS OF THE Nb–Zn SYSTEM. Evstyukhin, A. I.; Godin, Yu. G.; Yakovleva, V. B. Met. Metalloved. Chistykh Metal., Sb. Nauch. Rabot, No. 5, 51-9(1966). (In Russian).

A series of binary Nb–Zn alloys containing 4.9 to 52.7% Nb were melted from 99.8%-pure Nb and chemically pure Zn in Ar-filled airtight crucibles held at 1150°C for 20 hr. Alloys containing up to 20% Nb were dense. Those with a higher Nb content were porous. Alloys with the highest Nb content (96.9%) were made by remelting in an arc furnace. Metallographic examination showed that Nb-poor alloys consisted of Zn and a $NbZn_3$ phase, which increased in amount with increasing Nb content in the alloy. In an alloy containing 28.4% Nb, a $NbZn_3$ phase predominated with Zn grains between its grains; at still higher Nb contents the Zn grains dissolved. Alloys containing 35.8 to 39.4% Nb had a structure consisting of fine $NbZn_3$ grains and large grains of an Nb_2Zn_3 phase, the amount of which increased with increasing Nb content. The alloy containing 52% Nb consisted mainly of homogeneous grains assumed to have a composition close to that of Nb_2Zn_3, and of fine inclusions, probably of the NbZn phase, within the grains. An alloy containing 55.57% Nb had a two-phase structure consisting mainly of the Nb_2Zn_3 phase and small grains of the NbZn phase. But the alloy with 59.39% Nb consisted of the NbZn phase and a small amount of Nb_2Zn_3 grains. All alloys with more than 60% Nb contained metallic Nb. In an alloy containing 74.4% Nb, the NbZn phase was located along the boundaries of Nb grains that constituted the bulk of the alloy. A further increase in Nb content decreased the amount of the NbZn phase, and in an alloy containing 97% Nb, the NbZn phase was located along the boundaries of Nb grains in the form of a fine network. Thermal and x-ray diffraction analyses confirmed the existence of the $NbZn_3$, $NbZn_2$, Nb_2Zn_3, and NbZn intermetallic compounds. The Nb_2Zn_3 compound had the highest microhardness (890 kg/mm^2); the microhardness of the $NbZn_3$ compound was 302 kg/mm^2. (ATD)

6820 OPTICAL PROPERTIES OF EUROPIUM AND BARIUM. Mueller, W. E. (IBM Zurich Research Lab.). Solid State Commun., 4: 581-3(Nov. 1966).

Observed structure in the real part of the conductivity $\sigma(\omega)$ for the two elements Eu and Ba was assigned to optical interband transitions with the help of recent energy-band calculations. (auth)

6821 LOW-TEMPERATURE RECOVERY OF DEFORMED ZIRCONIUM. Swanson, M. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 44: 3241-57(Dec. 1966). (AECL-2815).

The low-temperature recovery of the electrical resistivity increment $\Delta\rho_0$ produced by deformation of polycrystalline Zr at 4.2°K was investigated. Particular attention was given to the large recovery stage occurring between 30 and 40°K, which amounted to 30% of $\Delta\rho_0$ for Zr containing ~0.070 at. % oxygen, but only 6% of $\Delta\rho_0$ for Zr containing ~0.015 at. % oxygen. By means of isochronal and isothermal anneals, this recovery stage was shown to be due to several first-order annealing processes (with activation energies between 0.105 and 0.125 eV), which were attributed to defect-oxygen atom interactions. Additional recovery peaks were observed at 190 and 310°K only for the lower-purity Zr, whose recovery to 360°K was approximately 80%. (auth)

6822 EFFECT OF A MAGNETIC FIELD ON THE THERMAL CONDUCTIVITY OF ERBIUM POLYCRYSTALS. Nikolskii, G. S.; Eremenko, V. V. (Physico-Technical Inst. for Low Temperatures, Kharkov). Phys. Status Solidi, 18: K123-5(Dec. 1, 1966).

The relative change of the thermal conductivity of Er crystals in magnetic fields up to 20 kOe was measured in the temperature range 20 to 100°K. The magnitude of the relative change was found to have a positive sign in the whole range of fields and temperatures investigated, and is considerably greater than the galvanomagnetic effect under corresponding conditions. (A.G.W.)

6823 ELECTRICAL RESISTIVITY AND LONGITUDINAL ELECTRICAL MAGNETORESISTIVITY OF PALLADIUM-RICH PALLADIUM–ERBIUM ALLOYS AT LOW TEMPERATURES. Arajs, S.; Dunmyre, G. R.; Dechter, S. J. (United States Steel Corp. Research Center, Monroeville, Pa.). Phys. Status Solidi, 18: 505-9(Dec. 1, 1966).

Electrical resistivity of palladium–erbium alloys, containing 0.5, 1.0, 1.9, 3.9, 5.2, and 6.6 at. % erbium, have been studied between 4 and 40°K. In spite of localized magnetic moments on erbium atoms, no anomalies of any type are observable in the electrical resistivity curves. These palladium–erbium alloys approximately obey the Matthiessen rule. Longitudinal magnetoresistivity measurements at 4.2°K in fields up to 60 kOe have been made on the same alloys. The total longitudinal magnetoresistivity rapidly decreases from positive values to zero values with increasing erbium concentrations. The magnetoresistivity for 5.2 and 6.6 at. % erbium alloys is essentially zero at any magnetic field value. The change in the magnetic component of the total resistivity has been found to be extremely small. The electrical resistivity increase due to 1 at. % erbium in palladium is about 2.9 $\mu\Omega$cm. (auth)

6824 SOLUTION HARDENING IN NIOBIUM. Harris, B. (Pratt and Whitney Aircraft, North Haven, Conn.). Phys. Status Solidi, 18: 715-30(Dec. 1, 1966).

A study has been made of the solution hardening of niobium by tantalum, vanadium, zirconium, and tungsten. It is found that hardening is linear with composition at small concentrations and is simply related to the sum of the atomic size and elastic modulus differences. Agreement with the solution-hardening model of Fleischer for fcc metals is not exact, however, for the results indicate that the atomic size mismatch, rather than the elastic modulus difference, is the dominant factor in hardening. Strain hardening, strain-rate sensitivity, and temperature dependence of the flow-stress are studied, and it is shown that the basic deformation mechanism remains unaltered by solute additions. It is suggested that the solutes raise the long-range, athermal component of the flow-stress and reduce the short-range, thermally activated component. (auth)

6825 ANODNAYA ZASHITA METALLOV. DOKLADY 1-i MEZHVOZOVSKOI KONFERENTSII. (Anodic Metal Protection. First Conference of University Association). Bogoyavlenskii, A. F. (ed.). Moscow, Izdatelstvo Mashinostroenie, 1964. 528p.

Anodic protection of light metals and alloys (Al, Ti, Mg, V, Nb, Zr, Cd, and Zn, etc.) against corrosion is discussed in the 45 reports included. Theory and practical applications of anodizing, the anodic structures and properties, and the electrochemical processes are analyzed. The book is designed for the needs of chemists and electrochemists. (R.V.J.)

Structure and Phase Studies

Refer also to abstracts 6773, 6791, 6796, and 6804.

6826 (COO-1456-3) HIGH TEMPERATURE ANNEALS OF DEFECTS QUENCHED IN METALS. Technical Progress Report. Emrick, Roy M. (Arizona Univ., Tucson. Dept. of Physics). Nov. 1966. Contract AT(11-1)-1456. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A circuit was developed for accurate pulsing of high-temperature anneals, and eight runs were made on gold wires. The effective vacancy motional energy as determined from the preliminary results was found to be comparable with values obtained by conventional methods. Possible reasons for this result are discussed. Measurements of the pressure effect in the annealing of quenched-in resistance in aluminum are reported briefly. (D.L.C.)

6827 (INR-721/II/PS) OPREDELENIE EFFEKTIVNOGO SPEKTRA V NEITRONOSTRUKTURNYKH ISSLEDOVANIYAKH METODOM VREMENI PROLETA. (Studies on the Effective Neutron Spectrum in the Structural Investigations by the Time of Flight Method). Sosnovska, I.; Sosnovski, E. (Institute of Nuclear Research, Warsaw (Poland)). 1966. 10p. (In Russian). Dep. mn.

Some experimental methods of effective neutron spectrum determination are described. This spectrum is used in neutron diffraction structure analysis performed by the time-of-flight method. (auth)

6828 (ORNL-tr-1410) X-RAY EXAMINATION OF URANIUM OXIDES OF THE UO_2 TYPE AFTER QUENCHING. Belbeoch, B.; Laredo, E.; Perio, P. Translated by R. G. Mansfield (Oak Ridge National Lab., Tenn.), from J. Nucl. Mater., 13: 100-6(1964). 14p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Results of x-ray-diffraction studies of uranium oxides in the composition range of UO_2–$UO_{2.25}$, which were heated to high temperatures and quenched, showed that the U–O phase diagram was more complex than previously assumed. It was found that U_4O_9 may have at least two polymorphic modifications. Treatment temperatures were found to be critical; the oxide $UO_{2.16}$ gave different results at 1030, 1080, and 1120°C. A distinct phase at 1080°C was observed which had a parameter of a = 5.4573 Å. The method of quenching the specimens in sealed silica capillaries was not appraised as the most suitable because of breakage during quenching, reoxidation of the oxides, and possible contamination by silica. Further studies require development of containers inert to uranium oxides. (P.G.C.)

6829 THE THETA PHASE IN THE PLUTONIUM–ZIRCONIUM SYSTEM. Berndt, A. F. (Univ. of Missouri, St. Louis). J. Less-Common Metals, 12: 82-3(1967).

The powder data of Marples (J. Less-Common Metals, 2(1960) 331) were re-examined in order to determine the structure and composition of the θ phase in the Pu–Zr system. The lattice constants and their standard deviations as estimated by least squares are: $\underline{a}$ = 10.893 ± 0.003 and $\underline{c}$ = 14.889 ± 0.007 Å. The space group is $P4_2/\underline{ncc}$. The density is 15.86 g/cm^3. (M.C.G.)

6830 LATTICE PARAMETERS OF SOME h.c.p. BINARY ALLOYS OF RHENIUM AND OSMIUM: Re–W, Re–Ir, Re–Pt; Os–Ir,

Os–Pt. Rudman, P. S. (Battelle Memorial Inst., Columbus, Ohio). J. Less-Common Metals, 12: 79-81(1967).

The lattice parameter–average group number relationship was explored for the Re–W, Re–Ir, Re–Pt, Os–Ir, and Os–Pt alloys. X-ray diffraction patterns were obtained and a computer program used to calculate lattice parameters. The results indicated that no unique lattice parameter–average group number relationship exists for these alloys although there was a tendency for c/a to decrease in the vicinity of GN = 8. (M.C.G.)

6831 RARE-EARTH INTERMEDIATE PHASES. IV. THE HIGH-TEMPERATURE LATTICE SPACINGS OF SOME R.E.Pd_3 PHASES. Harris, I. R.; Raynor, G. V.; Winstanley, C. J. (Birmingham Univ., Eng.). J. Less-Common Metals, 12: 69-74 (1967).

The lattice spacings of $CePd_3$ expand with increasing temperature much more rapidly than those of $GdPd_3$, $YbPd_3$, and $SnPd_3$, (included for purpose of comparison) and this is interpreted in terms of a variable occupancy of the 4f-states of the Ce atoms, such that conduction band → 4f-transitions occur with increasing temperature. The expansion characteristics of $YbPd_3$ and $YbIn_3$ are distinctly different from each other and this is probably due to different valency states of Yb in these two phases. (auth)

6832 PREPARATION AND X-RAY INVESTIGATION OF PLATINUM ALLOYS WITH THE RARE-EARTH METALS (Pt_5Ln AND Pt_3Ln PHASES). Bronger, W. (Univ., Muenster, Ger.). J. Less-Common Metals, 12: 63-8(1967).

A series of phases of the type Pt_5Ln were prepared by reacting Pt with the oxides of the lanthanides, from La to Tm, in a hydrogen atmosphere. X-ray investigations showed that three related structure types occur. The compounds with the lighter lanthanides form the Cu_5Ca-structure, whereas for those with the heavier members of the lanthanides new but similar structures are observed. These structure changes are discussed in detail. The Pt_3Ln-phases from Ho to Lu, prepared in a similar way, are isostructural with Cu_3Au. (auth)

6833 ABNORMAL CHANGES IN X-RAY INTERFERENCE PICTURE DURING ANNEALING OF NICKEL–BERYLLIUM ALLOYS. Varli, K. V.; Skakov, Yu. A.; Umanskii, Ya. S. (Moscow Inst. of Steel and Alloys). Fiz. Metal. Metalloved., 21: 779-81(May 1966). (In Russian).

In order to further study the abnormal two-dimensional scattering effects observed during the early stages of the aging of Ni–Be alloys, polycrystalline specimens of alloys No. 1 and 2, containing 1.32 and 2.2 weight % of Be, respectively, were subjected to x-ray diffraction analysis after treatment, resulting in maximum hardness. Marked changes were noted in the interference picture after a few minutes of aging, including a shifting of the (111) and (200) lines toward each other, appearance of asymmetry at the (111) line toward the low-angle side, and a decrease of the intensity of the (200) line. These changes were enhanced in the case of the 2.2% Be alloy. The packing deformation defect was calculated to reach 5% for alloy 1 and 1 to 16% for alloy 2; on this basis it was assumed that the shift of the lines must be due to additional structural changes or that the calculation method used for determining defect concentrations in pure metals should not be applied to aged alloys. The shift of the lines cannot be attributed to a monoclinic shift alone. (TTT)

6834 EFFECTS OF HIGH PRESSURE ON THE PHASE EQUILIBRIA OF SOME PLUTONIUM ALLOYS. Liptai, R. G.; Friddle, R. J. (Argonne National Lab., Ill.). J. Nucl. Mater., 21: 114-16(1966).

The effects of high pressure and temperature on the phase equilibria of some Pu–Ga and Pu–Ti alloys were investigated. Nearly equivalent results were obtained with 3 at. % Ga alloy and unalloyed Pu. The phase diagrams of three Pu–Ti alloys (1, 3, and 6 at. %) were studied. The temperature hystereses, i.e., the differences between the temperature at the start of the transformations on heating and cooling, were large (about 50% greater than Pu–3 at. % Ga data), therefore it was assumed that the equilibrium phase boundaries were located midway between the temperatures at the start of the transformations on heating and cooling. Metallographic examination after pressure–temperature treatments did not reveal a second phase in any of the Pu–Ti alloys. Increasing Ti additions appeared to stabilize the β, γ, and ϵ phases with pressure, as compared with unalloyed Pu. In all metals other than Pu, Ga, and Bi, the melting curve increased with increasing pressure, i.e., the slope is positive. Increasing Ti concentrations tended to make the melting curve of the Pu–Ti alloys more normal, i.e., the slope became less negative. (D.H.M.)

6835 RELATIONSHIP OF MICROSTRUCTURE TO SOME MECHANICAL PROPERTIES OF Ti–8Al–1V–1Mo. Blackburn, M. J. (Boeing Scientific Research Labs., Seattle). Trans. Amer. Soc. Metals, 59: 695-708(1966).

The phase structure of the alloy Ti–8Al–1V–1Mo after duplex and mill annealing treatments (i.e., after different cooling rates from the solution treatment temperature, 790°C) was studied by transmission electron microscopy. An ordering reaction was found to occur in the α-phase; the critical temperature for this reaction was ~550°C. The β phase in duplex annealed material was unstable and transformed when tempered at intermediate temperatures; the general form of these transformations was consistent with sequences observed in other Ti alloys. Dislocation arrangements in the α phase after deformation are described and compared with those observed in pure Ti and a Ti–9Al alloy. On the basis of these observations a model is advanced to account for the differences in yield stress of mill and duplex annealed material. Because the presence of hydride platelets can obscure many of the structures, the contamination of thin foil specimens by hydrogen is discussed. (auth)

6836 CONSTITUTION OF BINARY ALLOYS, FIRST SUPPLEMENT. Elliott, Rodney P. McGraw-Hill Series in Materials Science and Engineering. New York, McGraw-Hill Book Co., 1965. 907p. $35.00.

Critical reviews of the literature pertinent to binary equilibriums published through December 1961 are presented. A total of 8,100 system references was consulted and written reviews are included for 1,719 binary systems. Four hundred and thirty-five figures are included. (M.C.G.)

Radiation Effects

Refer also to abstracts 7358 and 7367.

6837 (GA–7436) PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS. Quarterly Progress Report, May 1, 1966–July 31, 1966. Trozera, T. A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 17, 1966. Contract AT(04-3)-167. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effects of neutron damage in a high-purity bcc metal were studied by means of liquid-helium-temperature resistance measurements, mechanical-property measurements, and stored-energy measurements. (M.H.R.)

6838 (NRL–6420) INITIAL EVALUATIONS OF METALLURGICAL VARIABLES AS POSSIBLE FACTORS CONTROLLING THE RADIATION SENSITIVITY OF STRUCTURAL STEELS. Hawthorne, J. R.; Steele, L. E. (Naval Research Lab., Washington, D. C.). Sept. 29, 1966. Contract AT(49-7)-2435. 33p. (CONF-660607-5). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 3rd International Symposium on the Effects of Irradiation on Structural Metals, Atlantic City.

Results from screening studies demonstrate that the radiation sensitivity of a steel can be altered appreciably through heat treatment practices and that microstructure plays a dominant role in radiation sensitivity development. A tempered martensite structure was noted to be generally less radiation sensitive than tempered upper bainite and ferrite structures. The data also indicate that vacuum melting and the minimization of residual element content yields steels having a superior irradiation performance compared with steels produced by conventional open hearth melting. However, long-term stress-relieving heat treatments were not found to alter the irradiation response of A302-B steel. (J.R.D.)

6839 AN APPARATUS FOR THE MEASUREMENT OF THE THERMAL CONDUCTIVITY OF IRRADIATED SOLIDS IN THE RANGE 100 TO 200 DEG C. Jaffe, D. (Bettis Atomic Power Lab., Pittsburgh). pp VII.B.1-29 of Proceedings of the 4th Conference on Thermal Conductivity. San Francisco, U. S. Naval Radiological Defense Lab., 1964.

A comparative type apparatus was developed for measuring the thermal conductivity of thin (0.050 to 0.150 in.) specimens of solid materials having relatively high thermal conductivities, both prior to and after irradiation. The principle of measurement of the apparatus involves relating the time to boil a given volume of a liquid to the thermal resistance of the specimen, where thermal resistance = thickness/area × thermal conductivity. The apparatus was calibrated for use with one-half-inch square specimens having thermal resistance values in the range of approximately 1 to 10 sec-°C/cal. In this range of thermal resistance values, the precision of the apparatus was found to be ±0.05 to 0.1 sec-°C/cal. To date, all measurements were carried out at an average specimen temperature of 120°C, but this range can be extended to 100 to 200°C without major modifications to the apparatus. Also, it is felt that the apparatus can readily be calibrated and used for measurements of specimens with thermal resistance values well above 10 sec-°C/cal. Complete procedures for the remote in-cell measurement of the thermal conductivity of irradiated specimens were developed and are described in detail. (auth)

6840 HARDENING IN MILD STEEL AT HIGHER IRRADIATION TEMPERATURES. Stefanovic, V. M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Iron Steel Inst. (London), 204: 987-90(Oct, 1966).

Combined effects of irradiation temperature and grain size on radiation hardening of mild steel are described. This form of hardening is essentially similar to that occurring in strain-hardened steel. Equations are given which express irradiation effects as (a) change in lattice friction stress, (b) friction stress, and (c) stress required to generate a new dislocation in the lattice plane. Fine-grain-size controlled steel was most resistant to radiation hardening. It is postulated that susceptibility to radiation hardening is due to differences in distribution of impurities, precipitates, and alloying elements in alpha grains. Reduction in yield strength after irradiation at 400 and 420°C is ascribed to decrease in number of point-defect clusters and dislocation loops. (P.G.C.)

6841 HYDROGEN IN IRRADIATED PRESSURE VESSEL STEEL. Rossin, A. D. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 389(Oct.-Nov. 1966).

6842 ANNEALING OF IRRADIATED A302-B STEEL. Seman, D. J.; Pasierb, E. J. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 389-90(Oct.-Nov. 1966).

6843 FRACTURE TOUGHNESS OF IRRADIATED A302-B STEEL AS INFLUENCED BY MICROSTRUCTURE. Johnson, Richard E. (General Electric Co., Evendale, Ohio); Pasierb, Edward J. Trans. Amer. Nucl. Soc., 9: 390-2(Oct.-Nov. 1966).

6844 MICROSTRUCTURE: A FACTOR IN RADIATION EMBRITTLEMENT SENSITIVITY OF STRUCTURAL STEELS. Hawthorne, J. R.; Gray, R. A. Jr.; Steel, L. E. (Naval Research Defense Lab., Washington, D. C.). Trans. Amer. Nucl. Soc., 9: 392(Oct.-Nov. 1966).

6845 NUCLEAR IRRADIATION EFFECTS ON THE DYNAMIC BEHAVIOR OF PURE ALUMINUM. Zamrik, Sam Y.; Hu, Ling W. (Pennsylvania State Univ., University Park). Trans. Amer. Nucl. Soc., 9: 429-30(Oct.-Nov. 1966).

6846 FAST-NEUTRON EFFECTS ON THE VACUUM WALL OF A THERMONUCLEAR REACTOR. Axtmann, Robert C.; Hite, J. Roger; Price, William G. Jr. (Princeton Univ., N. J.). Trans. Amer. Nucl. Soc., 9: 431(Oct.-Nov. 1966).

6847 HELIUM PRODUCTION BY (n,α) REACTIONS IN STAINLESS STEEL. DePino, A. Jr. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 386(Oct.-Nov. 1966).

6848 ELECTRON MICROSCOPY STUDY OF TYPE-348 STAINLESS-STEEL FUEL-ELEMENT CLADDING. Aqua, E. N.; Smalley, W. R.; Owens, C. M. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 386-7(Oct.-Nov. 1966).

6849 THE EFFECTS OF IRRADIATION ON THE CREEP AND TENSILE PROPERTIES OF ANNEALED AISI 304 STAINLESS STEEL. Irvin, J. E.; Williams, J. A. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 387-8(Oct.-Nov. 1966).

6850 POSTIRRADIATION MECHANICAL PROPERTY IMPROVEMENT IN HASTELLOY X-280 AND INCONEL-600. Levy, I. S. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 388-9(Oct.-Nov. 1966).

6851 DEFLECTION OF A URANIUM ROD FOLLOWING UNSYMMETRIC SWELLING. Roesel, R. (Therm-Atom AG, Winterthur, Switzerland). Neue Tech., 8: 308-14(Oct, 1966). (In German).

Metallic U has the property of swelling during irradiation in the reactor. Due to irregularities in the distribution of the neutron flux the volume increase is not axially symmetric in a cross section of a bar, so that the bar will bend. Against this act supporting fins of the Mg cladding, which rest on the graphite container. Thus the creep properties of U and Mg are important. An equation giving deflection and pressure distribution is discussed and a method of solution given. The calculations were carried out for two ring elements (short and long) and for the fuel element of the Lucens Reactor. (auth)

6852 EFFECT OF A PHASE TRANSFORMATION ON THE OCCURRENCE OF HIGH TEMPERATURE EMBRITTLEMENT AFTER NEUTRON IRRADIATION. Boehm, H.; Hauck, H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater., 21: 112-13(1966). (In German).

The effect of a phase transformation on high-temperature embrittlement after neutron irradiation was studied using a ferritic chromium steel, whose $\alpha-\gamma$ transformation began at approximately 825°C. The samples after irradiation with an integrated fast neutron flux of 1.6×10^{18} n/cm^2 were tested with a stretching velocity of 0.1/min at room temperature and between 450 and 880°C. Whereas at room temperature the yield point and tensile strength were increased 25 and 10%, respectively, after neutron irradiation, the effects of irradiation on these parameters were no longer evident above 450°C. Irradiation did not affect the breaking elongation up to the beginning of the $\alpha-\gamma$ transformation. These results indicate that in the alloy studied a high-temperature embrittlement first occurred when the ferritic–austenitic transformation began. The origin for this behavior can be that the occurrence of the high-temperature embrittlement is bound to a face-centered-cubic matrix or that the increasing dissolution of the carbide particles at the completion of the conversion and the connective transition leads to an extensive homogeneous structure for the introduction of the embrittlement. (J.S.R.)

6853 EFFECT OF FISSION FRAGMENT IRRADIATION UPON THE OXIDATION OF A 20 WT. PERCENT Cr, 25 WT. PERCENT Ni, Nb STABILIZED STAINLESS STEEL BY OXYGEN AT 650 DEG C. Bennett, M. J.; Chaffey, G. H.; Blythe, P. C.; Antill, J. E. (United Kingdom Atomic Energy Authority, Harwell, Eng.). J. Nucl. Mater., 21: 1-13(1966).

The oxidation of a 20 wt % Cr 25 wt % Ni, Nb stabilized austenitic steel in O_2 at 650°C was studied during fission fragment irradiation. The exposure period varied up to 3700 hr and the fission fragment flux was 7×10^8 ff/cm^2·sec. By comparison with unirradiated controls, the oxidation was enhanced by the fission recoil bombardment but was not influenced by the associated incident reactor radiation. The enhancement increased with time of exposure and the magnitude of oxidation increased by a factor of between 2 and 4 after 3700 hr. On the average, 15 U atoms were ejected with each fission fragment emerging from the U_3O_8 source. Contamination of the oxide film on the steel with U and fission products was unlikely to have influenced the oxidation. Apart from the contamination, the irradiation did not alter measurably either the composition or the crystal structure of the oxide. Displacement damage in the protective oxide film, as a direct result of fission recoil bombardment, is believed to be primarily responsible for the enhanced attack. (auth)

6854 RESISTIVITY RECOVERY OF DILUTE ALLOYS OF SILVER, COPPER, AND GOLD, PROTON IRRADIATED AT 80 DEG K. Grenning, Daniel Albert. Urbana, Ill., Univ. of Illinois, 1966. 102p.

Thesis.

Ag–Be, Ag–Li, Cu–Be, Au–Mg, and Au–Al were irradiated by 12 MeV protons at 80°K. High resolution isochronals were then obtained at –130°C to 90°C and activation energies were determined every 10°C using the change of slope method. The order associated with the reaction kinetics was determined at temperatures appropriate for the various annealing peaks by fitting 240 minute isothermal anneals to first or second order. The recovery of Ag and Cu alloys showed similarity to pure Ag and Cu, but the Au alloy's recovery was altered as compared with pure Au. Activation energies for the stage III defect in Ag, Cu and Au were found to be .64, .71 and .70 eV respectively. The Cu and Ag alloys both had a small first order recovery stage near the low temperature side of the main stage III annealing peak. The main stage III peak obeyed second order kinetics in all cases. In the Au alloys the stage III recovery was composed of a main second order annealing peak with a small second order annealing peak on each side of the main peak. These annealing results were fitted to the various models for the recovery of damage and some conclusions are drawn. (auth)

Ceramics and Cermets

Preparation and Fabrication

Refer also to abstracts 6124, 6781, 6872, 8175, 8176, and 8178.

6855 (AD–633669) ELECTRICAL AND MAGNETIC PROPERTIES OF SINGLE CRYSTALS OF RARE EARTH TUNGSTEN BRONZES AND URANIUM TUNGSTEN BRONZES. Collins, Charles V. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Mar. 1966. 84p. (GSP/PH–66-03). CFSTI $3.00 cy, $0.65 mn.

Thesis.

Rare earth tungsten bronze single crystals were prepared by the method of electrolysis. Sodium tungsten bronze single crystals with x ranging between .37 and .81 were also prepared. Powder samples of a uranium tungsten bronze were synthesized by a thermal reaction of WO_3, UO_2, and W. Magnetic measurements indicated that U is tetravalent in the tungsten bronze compound. All samples were investigated by x-ray diffraction methods. Conductivity measurements were made on all samples and the metallic nature of the cubic rare earth and uranium tungsten bronzes was established. (auth)

6856 (N-66-30848) STUDY OF GROWTH PARAMETERS FOR REFRACTORY CARBIDE SINGLE CRYSTALS. Quarterly Status Report No. 9, March 1–June 1, 1966. Bartlett, R. W. (Stanford Research Inst., Menlo Park, Calif.). June 27, 1966. Contract NASr-49(19). 17p. (NASA-CR-76365). CFSTI $3.00 cy, $0.65 mn.

The arc-Verneuil crystal growing furnace was installed and TaC crystal growth experiments were resumed. Mechanical operation of the crystal grower is satisfactory. It produces uniform operating conditions and symmetrically shaped boules. However, a major impediment to TaC crystal growth is decarburization of the boule, which occurs in all atmospheres in which a low voltage ac arc is stable. Under operating conditions that provide improved stoichiometry ratios arc stability is still quite poor. HfC and TaC–HfC powders in a size range suitable for crystal growth were ordered. Metal solution growth experiments did not yield TaC crystals larger than 0.2 mm, and therefore, work in this area was discontinued. (auth)

6857 (NUMEC-3524-22) DEVELOPMENT AND TESTING OF PuO_2–UO_2 FAST REACTOR FUELS. Progress Reports, April 1, 1966–June 30, 1966. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Sept. 20, 1966. Contract AT(30-1)-3524. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The fuel pellets for the EBR-II fuel rods and library samples have been produced. Heat treatment procedures have been developed for changing the as-sintered hypostoichiometric fuel to stoichiometric and hyperstoichiometric. The microstructures of the various pellet density groups are compared. The 41 fuel rods for EBR-II irradiation have been completed. Reactions with 316L stainless steel were found in the sintered PuO_2–UO_2 clad metal samples. Results of the runs made using the 75-ton press in the mixed-oxide extrusion development are given. (D.L.C.)

6858 (Y-DA-1412) CARBIDE TOOLS: THEORY AND PRACTICE. Hurst, John S. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Nov. 29, 1966. Contract W-7405-eng-26. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Methods for preparing and processing sintered carbides for tools are presented. Capabilities of carbide tools, when compared with metal cutting tools, are discussed and guides for selection of tools for various applications are defined. Benefits and disadvantages of additions of carbides of Ti, Ta, Nb, and other metals, to straight W–Co grades are evaluated, as are the effects of Co content and grain size. Precautions to be observed in both laboratory and production tests are summarized and the importance of tool geometry and tool insert mounting is stressed. (P.G.C.)

6859 SINTERING OF YTTRIUM OXIDE. Furlong, LeRoy R.; Domingues, Louis P. (Bureau of Mines, College Park, Md.). Amer. Ceram. Soc. Bull., 45: 1051-4(Dec. 1966).

Y_2O_3 compacts of density exceeding 97% of theoretical were obtained by sintering at the relatively low temperature and short soak time of 1600°C and 1 hour. Distributions of particle-size of powder and of pore-size of green compact were found to affect the sinterability of Y_2O_3 to a great degree. Variation in powder properties was obtained by decomposing six salts of Y. (auth)

6860 FABRICATION AND EVALUATION OF EUROPIUM TITANATE/STAINLESS STEEL CERMETS. Barr, H. N. (Hittman Associates, Inc., Baltimore). Trans. Amer. Nucl. Soc., 9: 401-3(Oct.-Nov. 1966).

6861 DESIGN OF A REMOTE SYSTEM FOR FABRICATION OF $(Th-^{233}U)O_2$ METAL-CLAD FUEL ELEMENTS. Sease, J. D.; Pratt, R. B.; Davis, F. C.; Lotts, A. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 613(Oct.-Nov. 1966).

6862 MACHINE TO TRANSFER POWDERED RADIOACTIVE FUEL REMOTELY. Davis, F. C.; Pate, W. A.; Sease, J. D. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 613-14(Oct.-Nov. 1966).

6863 MACHINE TO REMOTELY FILL AND COMPACT NUCLEAR FUEL TUBES BY VIBRATION. Cannon, D. D.; Davis, F. C.; Sease, J. D. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 614(Oct.-Nov. 1966).

6864 PREPARATION OF URANIA AND URANIA–ZIRCONIA MICROSPHERES BY A SOL-GEL PROCESS. Haas, P. A.; Clinton, S. D.; Kleinsteuber, A. T. (Oak Ridge National Lab., Tenn.). Can. J. Chem. Eng., 44: 348-53(Dec. 1966). (ORNL-P-2096).

The sol-gel process was applied to the preparation of relatively high-strength, spherical particles of UO_2, UO_2–ZrO_2, and UC_2, which had diameters of 50 to 500 microns and densities of 80 to 100% of the theoretical densities. (J.G.B.)

6865 EPITAXIAL GROWTH OF UO_2 ON GRAPHITE. Hoerl, E. M.; Heilmann, P. (Reaktorzentrum, Seibersdorf, Austria). J. Nucl. Mater., 21: 96-9(1966). (SGAE-M-6/1966).

Experimental conditions for the epitaxial growth of UO_2 crystals on graphite lamellas were studied. The two experimental techniques employed were evaporation on substrates at room temperature with heat treatment afterwards, at temperatures between a few hundred and 1000°C, in the heating stage of the electron microscope and evaporation on substrates at elevated temperatures and observation of the film structure at room temperature. The first method was the most successful one for the production of large crystals with maximum linear dimensions of 0.3 μm; the second method yielded crystals with preferred orientation in respect to the crystallographic directions of the graphite substrate. (D.H.M.)

6866 VAPOR PHASE SINTERING PROCESS. Hammond, J. P. (to U. S. Atomic Energy Commission). U. S. Patent 3,294,877. Dec. 27, 1966.

An improved method is given for forming dense compacts of UC and UN which comprises sintering the compact in the presence of and in contact with a vaporized metal atmosphere, the vaporized metal being selected from a metal whose oxide has a higher negative free energy of formation than UO_2, and being further characterized in that it has a vapor pressure of at least 10^{-5} mm Hg at the sintering temperature. (AEC)

6867 METHOD OF TEMPERATURE CYCLING FERROELECTRIC CERAMICS THROUGH A TEMPERATURE RANGE BELOW THE CURIE POINT THEREOF. Graham, Howard M.; Phelps, Paul L. (to U. S. Atomic Energy Commission). U. S. Patent 3,278,769. Oct. 11, 1966.

A method for the direct conversion of heat to electrical energy is described in which a bound charge ferroelectric ceramic is temperature-cycled between a high and low temperature below the Curie temperature of the ceramic. The energy expended in expanding and contracting the ceramic by the temperature cycling generates an alternating potential difference across opposing faces of the ceramic body, from which the potential is extracted by conductors. (AEC)

6868 HOLLOW, SPHERICAL UO_2 NUCLEAR FUEL PARTICLES. Barr, H. N.; Sundquist, L. A. (to U. S. Atomic Energy Commission). U. S. Patent 3,294,698. Dec. 27, 1966.

Spherical, refractory, nuclear fuels, comprising hollow spheres of UO_2 forming inner, uniform, single, central closed cells are described. This fuel is particularly advantageous in nuclear fuel elements because the spherical form effectively contains fission products produced in a reactor and minimizes fracturing or other damage of the particles during fabrication of fuel elements. (AEC)

6869 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUELS. Dalton, John Townsend (to United Kingdom Atomic Energy Authority). British Patent 1,047,399. Nov. 2, 1966. Filed Nov. 25, 1963.

A new and improved fuel for gas-cooled reactors consists of mixed U and Pu sesquicarbides. The mixture contains 8 to 40 mole % of Pu_2C_3 and may be fabricated in the manners suitable for ordinary ceramic fuels. The fuel is stable up to temperature of about 1750°C, depending upon the mole % of Pu_2C_3. (B.L.M.)

6870 PROCESS OF FABRICATION OF SINTERED COMPOUNDS BASED ON URANIUM AND PLUTONIUM. Pascard, Roger (to Commissariat a l'Energie Atomique). U. S. Patent 3,275,564. Sept. 27, 1966. Priority date June 20, 1962, France.

Processes were developed for the preparation and fabrication of nuclear fuel elements based on compounds of U and Pu. The compounds having a Pu content of 30%, are arc-melted and ground under Ar to an average grain diameter of 40 μ. These powders sinter more readily than those obtained by calciothermy or by decomposition of the hydrides. For the preparation of nuclear fuels based on UC and ThC, the finely ground alloy powder is mixed with the required amount of C, compacted, and heated under vacuum for 10 hr at 1200°C. These mixed carbides are further ground for 20 min with 1 wt % of naphthalene and 0.05 wt % of Ni compacted, and sintered under vacuum at 1450°C for 4 hr. Final density obtainable for the carbide fuel elements is 13.45 g/cm^3. Other metals which can be added to the powdered alloy include Mo, Nb, Ta, and Zr. Fuels based upon U and Pu mononitrides are produced by mixing the finely ground alloys with stoichiometric quantities of N_2, heating for 1 hr at 350°C, to form the nitrides, and then sintering by one of several methods. (P.G.C.)

6871 NUCLEAR FUEL BODY CONTAINING URANIUM CARBIDE SPHEROIDS COATED WITH SILICON CARBIDE. Ingleby, Byran Edward (to United Kingdom Atomic Energy Authority). U. S. Patent 3,276,968. Oct. 4, 1966. Priority date Apr. 13, 1962, Great Britain.

A method was developed for coating UC spheroids with SiC, and for dispersing the spheroids in a matrix of SiC to form nuclear fuel elements. The process includes spheroidizing a mixture

of C and UO_2, reaction sintering to form dense spheroids of UC, and coating the individual spheroids with SiC in a fluidized bed by decomposition of methyl trichlorosilane. The coated spheroids are mixed with SiC (600 mesh), colloidal graphite, and slurrying agents, and extruded to form rods. The extruded rods are coated with beta SiC in graphite crucibles, under vacuum, by an exothermic reaction between SiC and colloidal graphite at 1420°C. A further step bonded caps of SiC to the ends of the rods, thus completely sealing them to allow use in contact with reactor coolants. (P.G.C.)

Properties Evaluations

Refer also to abstracts 5986 and 6804.

6872 (TID–7637) MEETING ON CHARACTERIZATION OF URANIUM DIOXIDE HELD AT OAK RIDGE NATIONAL LABORATORY, DECEMBER 12–13, 1961. (Oak Ridge National Lab., Tenn.). Oct. 1, 1962. Contract W-7405-eng-26. 494p. Dep. mn, CFSTI $3.00 cy, $0.65 mn.

Papers on the following subjects are included: properties of UO_2 powders and sintered pellets with particular reference to ADU oxide; characterization of UO_2 powders for sintering; preparation and sintering of UO_2 powders of high reactivity; establishing methods of characterizing UO_2 powder; preparation of UO_2 powders by wet method; the role of F in low-temperature sintering of UO_2; pore structure and sintering of UO_2; UO_2 powder characteristics and ceramic performance; improvement of the sinterability of UO_2; desirable properties of UO_2 for nonsintered fuel applications; Fe, C, and N impurities in PWR-2 seed fuel; microstructures and effects of impurities and sorbed gases in UO_2; characterization methods for ceramic-grade UO_2, PuO_2, and mixed UO_2-PuO_2 powder; relation between process variables and final properties of ceramic-grade UO_2, UO_2-PuO_2, and PuO_2; proposed ASA standard for nuclear-grade UO_2; multicycle reprocessing and refabrication experiments on sintered UO_2–fissia pellets; characterization and standardization of urania and thoria–urania powders for extrusion; chemical analysis of UO_2; characterization of UO_2 by petrographic techniques; characterization of spheroidal UO_2 particles; gaseous and trace impurities in UO_2; volatile and nonvolatile impurities in fused UO_2; thermally activated gas release from fused UO_2; high-density UO_2 for nuclear fuel applications; oxidation and phase stability in solid-solution systems containing UO_2; compatibility between UO_2 and Al powder metallurgy alloys; theoretical x-ray density of 93% enriched UO_2; examination of high-burnup specimens from NS Savannah, Core I irradiation program; preparation methods and quality control of fused urania. (A.G.W.)

6873 TEMPERATURE DEPENDENCE OF ELASTIC CONSTANTS AND THERMAL EXPANSION FOR UO_2. Brandt, Ogden G.; Walker, Charles T. (Northwestern Univ., Evanston, Ill.). Phys. Rev. Lett., 18: 11-13(Jan. 2, 1967).

The thermal expansion has been measured as a function of temperature for UO_2 and shows a first-order transition at the Néel temperature. Elastic constants versus temperature also display a first-order transition except for C_{44}, which shows a lattice-spin effect 100° above the transition. (auth)

6874 DIFFUSION UNDER ELECTRIC FIELD OF O AT TEMPERATURES FROM 900 TO 1000 DEG C IN UO_2. Dornelas, W.; Lacombe, P. (Centre de Recherches Metallurgiques de l'Ecole des Mines, Paris). J. Nucl. Mater., 21: 100-4(1966). (In French).

The diffusion of O under the influence of an electric field was studied in fritted UO_2. Under a current density of the order 60 amp/cm² at 1,000°C the formation of two distinct metallic bands interposed between the tablet and the electrode was observed on the side of the Pt cathode. The two phases were identified as UPt_3 and UPt_5. It was concluded that a significant diffusion is produced under the effect of an electric field and the oxide is decomposed in the cathode region with the free U diffusing into the Pt. The O resulting from this decomposition diffused toward the anode and caused the formation of the substoichiometric oxide UO_{2+x} (X varying from 0 to 0.25). In electro-transport studies with U electrodes a participation of ions in the electric conductivity of UO_2 was detected. A significant oxidation of the anode was produced, but the cathode interface was unchanged. (J.S.R.)

6875 PROPERTIES OF URANIUM MONOPHOSPHIDE. Baskin, Y. (Argonne National Lab., Ill.). J. Amer. Ceram. Soc., 49: 541-6(Oct. 21, 1966).

Properties of UP were determined at room temperature and at high temperatures. Heating UP above 1400°C in vacuum resulted in preferential loss of P, producing a slight contraction of the cubic lattice. Effect of temperature and time on the densification, lattice structure, and stoichiometry of UP is discussed. Properties determined include hardness, melting temperature, electrical resistivity, vaporization behavior, irradiation behavior, thermal expansion, high-temperature compatibility, and chemical properties. (auth)

6876 ELASTICITY AND ANELASTICITY OF URANIUM OXIDES. Forlano, Roberto Jose. Urbana, Ill., Univ. of Illinois, 1966. 105p.

Thesis.

The elastic modulus and internal friction of uranium oxides were studied using the technique developed by Förster. The elastic modulus of stoichiometric urania at room temperature increased as the bodies became more dense. When the volume fraction porosity is smaller than 0.1, either linear or exponential equations can be used to calculate the elastic trait as a function of density. When the volume fraction porosity becomes larger than 0.1, a linear equation seems to be the most suitable. The linear expression is given by, $E = 2233.85\ (1-2.277P)$, and the exponential equation by, $E = 2243.56\ e^{-(2.52P)}$, where E is the elastic modulus of porous polycrystalline uranium oxide; and P is the volume fraction porosity. The elastic modulus of stoichiometric nonporous UO_2 at room temperature was found by extrapolation to be 2243.56 ± 22.1 Kilobars when using the exponential equation, and 2233.85 ± 22.05 Kilobars when employing the linear expression. The internal friction of stoichiometric urania decreased sharply as the grains became larger. Other microstructural characteristics, namely, number, size and position of pores also contributed to this behavior. In nonstoichiometric urania the logarithm of the internal friction increased linearly with increasing O-to-U ratio. Young's modulus for nonstoichiometric uranium oxide measured at room temperature decreased up to an O-to-U ratio content of about 2.05 and then started to level off. This was shown to be affected by the amount of U_4O_9 (or U_4O_{9-y}) precipitated. (J.R.D.)

6877 PROCEEDINGS OF THE 4th CONFERENCE ON THERMAL CONDUCTIVITY, OCTOBER 13–14–15–16, 1964 [SAN FRANCISCO]. San Francisco, U. S. Naval Radiological Defense Lab., 1964. 800p. (CONF-764–).

The publication of the conference proceedings is divided into 8 sections: fundamentals and standards, 5 papers; measurements and results, 3 papers; heterogeneous materials, 6 papers; high temperature, 5 papers; transient techniques, 6 papers; correlated properties, 3 papers; techniques and apparatus, 4 papers; and informal progress reports. Thirty-two formal papers were published, and separate abstracts were prepared for 7 of these. None of the informal progress reports were abstracted. One paper was previously abstracted for NSA. For abstract number of this paper see CONF-764 in the Report Number Index. (B.L.M.)

For abstracts of individual papers see: 6336, 6806, 6839, 6878–6880, and 7338.

6878 THERMOPHYSICAL PROPERTIES OF ZIRCONIUM–URANIUM HYDRIDE. Ambrose, C. J.; Taylor, R. E.; Finch, R. A. (Atomics International, Canoga Park, Calif. Pennsylvania State Univ., University Park). pp VI,A,1-21 of Proceedings of the 4th Conference on Thermal Conductivity. San Francisco, U. S. Naval Radiological Defense Lab., 1964.

The thermophysical properties of zirconium–uranium hydrides were measured, for varying amounts of hydrogen in the alloy, and for temperatures ranging from 25 to 500°C. The specific heat for material of H/Zr = 1.81 increased from 0.089 to 0.141 cal/g–°C at 100 and 500°C, respectively. With a simple theoretical model, calculations of specific heat agreed within 8% of experimental results on a variety of hydrogen compositions. Thermal conductivity was calculated from thermal diffusivity measurements, density, and specific heat. The thermal conductivity of the hydride was independent of temperature over the temperature range from 25 to 500°C, but increased significantly with increasing hydrogen content. Values for thermal conductivity varied from 0.031 to 0.055 cal/cm-°C-sec for material of H/Zr = 0.5 and 1.81, respectively. The formation of the hydrogen sublattice greatly increases the nonelectronic contribution to the thermal conductivity. (auth)

6879 SOME PARAMETERS OF THE THERMAL CONDUCTIVITY OF PYROLYTIC GRAPHITE. Pears, C. D.; Allen, J. G. pp II,C,1-44 of Proceedings of the 4th Conference on Thermal Conductivity. San Francisco, U. S. Naval Radiological Defense Lab., 1964.

The thermal conductivity of about 1500 specimens of manufactured pyrolytic graphite was evaluated by investigators at Southern Research Institute. These included many structures ranging from "not regenerative" to "continuously regenerative" and included grafoils and different heat treatments. Both flat plates and cylinders were studied. The conductivity is primarily a function of several parameters: the regenerative nature of the structure, the cracks per inch, and the heat treatment. Other parameters include cross-layer contributions and deposition tem-

perature (not necessarily related to macrostructure), with some inference that stress relief is a major effect and the primary result of the heat treatment in shifting the conductivity. The "c" direction conductivity was used successfully for quality control and on numerous occasions uncovered faulty batches that were not detected here by any other technique including photomicrographs. (auth)

6880 THERMAL CONDUCTIVITY AND ENTHALPY OF BeO AND THE BeO–UO_2 SYSTEM. Harrington, L. C.; Rowe, G. H. (Pratt and Whitney Aircraft-CANEL, Middletown, Conn.). pp II.E.1-30 of Proceedings of the 4th Conference on Thermal Conductivity. San Francisco, U. S. Naval Radiological Defense Lab., 1964.

Investigation of the thermal conductivity of the BeO–UO_2 system showed that the Rayleigh-Maxwell dilute dispersion equation applies to UO_2 dispersions in BeO as high as 50 vol %. The system was investigated using experimental values for BeO and two BeO–UO_2 mixtures, and literature values for UO_2. The experimental values were determined by the steady-state method of axial heat flow along a rod, with the specimen guarded from radial heat losses. The thermal conductivities of the BeO–UO_2 mixtures were calculated from the thermal conductivities of the constituents by several methods. Enthalpy of the BeO–UO_2 system was found to be directly related to the enthalpy of the constituents on a weight percent basis. The enthalpy of BeO and three BeO–UO_2 mixtures were measured from 0 to 1200 to 1500°C with a drop-type ice calorimeter similar to the one used at the National Bureau of Standards. Enthalpy values for UO_2 were taken from the literature. (auth)

6881 THERMAL INSULATOR FOR THE MODERATOR SPACE OF LIQUID-MODERATED NUCLEAR REACTORS. Scheickert, Hans; Roesler, Ulrich (to Siemens-Schuckertwerke Aktiengesellschaft). German Patent 1,216,446. May 12, 1966. Filed Apr. 30, 1957.

The thermal insulator of ceramic zirconium compounds, e.g., ZrO_2 or $ZrSiO_4$, consists of enamel layers attached to the insulating partition walls. (Gmelin)

6882 THERMOELECTRIC CONVERTER COMPOSITION. Precht, W. (to U. S. Atomic Energy Commission). U. S. Patent 3,294,688. Dec. 27, 1966.

A patent relating to a composition for thermoelectric converter elements, comprising a blend of Fe–doped strontium titanate blended with cerium titanate is described. The composition has good mechanical and electrical properties and is advantageously used with a radioactive heat source. (AEC)

Structure and Phase Studies

Refer also to abstracts 6827, 6872, and 7366.

6883 (INR–753/IV,II/C) THE STRUCTURE OF PYROLYTIC CARBON COATINGS ON URANIUM DICARBIDE PARTICLES. Mucha, Franciszek; Szmid, Zofia; Kalinowski, Bohdan (Institute of Nuclear Research, Warsaw (Poland)). Aug. 1966. 20p. Dep.

X-ray studies on the structure of pyrolytic carbons, deposited on UC_2 particles by thermal decomposition of CH_4 in a fluidized-bed, have been carried out. The influence of the temperature of pyrolysis at 1400 to 2150°C, and the concentration of CH_4 in the range 0.05 to 1.00 l CH_4/l [CH_4,Ar] has been examined. The structure of pyrolytic carbons depends largely on these parameters. The degree of ordering of the C structure increases with the increase in the temperature, and with the decrease in the concentration of CH_4. (auth)

6884 (ORNL-P-2515) RADIATION EFFECTS IN SEMICONDUCTORS. Crawford, James H. Jr. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 44p. (CONF-660923-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Solid State Conference on Interaction of Radiation With Solids, Cairo, Egypt.

The correlation between high-energy radiation damage to crystal lattices in semiconductors and the presence of imperfections in their crystalline structure was investigated. The nature of radiation defects, particularly in the systems of Ge and Si, was studied, as was the influence of these defects on the behavior of semiconductors. A result of the investigation was a better understanding of the complexities involved in the identification of the imperfections responsible for the acceptor and donor states in Ge, Si, and other semiconductors. (P.G.C.)

6885 (LA-tr-66-72) CONCERNING THE EXISTENCE OF A MONOCLINIC PHASE $UMoC_{2-x}$ IN THE URANIUM–MOLYBDENUM–CARBON TERNARY SYSTEM. Anselin, F.; Barthelemy, P. Translated by Gretchen R. Riese (Los Alamos Scientific Lab., N. Mex.), from Bull. Soc. Franc. Mineral. Crist., 89: 132-3(1966). 4p. Dep. mn. JCL $1.10 fs, $0.80 mf.

A monoclinic phase in the C–Mo–U system was found with the atomic composition 27% U, 27% Mo, and 46% C ($UMoC_{1.70}$). X-ray-diffraction studies showed that the phase has a base-centered monoclinic structure. The lattice parameters were a = 5.626 ± 0.005 A, b = 3.238 ± 0.002 A, and c = 11.661 ± 0.005 A. The measured density was 11.72 ± 0.07 g/cm³, and the calculated theoretical density was 11.78 g/cm³. The phase $UMoC_{1.70}$ is considered as being a distorted $UMoC_2$ phase deficient in carbon or $UMoC_{2-x}$ with x = 0.30. (A.G.W.)

6886 HIGH-TEMPERATURE, CONDENSED-PHASE EQUILIBRIA IN THE SYSTEM Ti–W–O. Chang, L. L. Y.; Scroger, M. G.; Phillips, B. (Tem-Press Research, Inc., State College, Pa.). J. Less-Common Metals, 12: 51-6(1967).

By using the sealed capsule technique, the system Ti–W–O was studied at high temperature. Along the TiO_2–WO_3 join, no compound was found and a binary eutectic exists at 1233°C and 64 mole % WO_3. In the ternary system, six crystalline phases, α-Ti, β-Ti, TiO, Ti_2O_3, Ti_3O_5, and TiO_2 were found stable at 1400°C in the titanium–oxygen system and all of them form equilibrium assemblages with tungsten. Also at 1400°C, a complete series of solid solutions formed along the join TiO_2–WO_2 and the formation of liquid in the oxygen-rich compositions did not develop beyond this join. At 1700°C, reactions between metallic titanium and the platinum capsules used became significant and destroyed the sealed systems. Equilibrium data could not be collected in the region W–TiO–Ti. No attempt was made to determine the actual pressure and the partial pressure of oxygen necessary to produce equilibrium relations in this system. Generalizations governed by the phase rule are stated. (auth)

6887 THE TERNARY SYSTEM: Re–Fe–B. Ganglberger, E.; Nowotny, H.; Benesovsky, F. (Univ., Vienna). Monatsh. Chem., 97: 718-21(1966). (In German).

The equilibria of the ternary system Re–Fe–B were established at 1100°C, two ternary phases being detected. The τ-phase, isotypic with $Cr_{23}C_6$, is characterized by an extended homogenous region $(Re_{0.31-0.87}Fe_{0.69-0.13})_{23}B_6$; $(Fe_{0.75-0.86}Re_{0.25-0.14})_3B$ crystallizes with the Ti_3P type. A large portion of the Fe can be substituted by Re within the Fe_2B phase. In contrast, the metal-metal substitution is much smaller for the other binary borides. The lattice parameters for $(Fe_{0.8}R_{0.2})_3B$ are a = 8.68, c = 4.32, and c/a = 0.499. (BBB)

6888 STACKING FAULTS AND ANTIPHASE BOUNDARIES IN U_4O_9. Blank, H.; Ronchi, C. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater., 21: 117-20(1966).

Mechanisms of creating antiphase boundaries in U_4O_9 are discussed. When cooling a crystal of perfect UO_2 sublattice through the critical temperature, the ordering process starts simultaneously at many different nuclei, which for statistical reasons cannot all be in phase with respect to only one of the many possible oxygen superlattices. The region where two different growth areas touch each other therefore usually contains an antiphase boundary. An antiphase boundary with known displacement Vector R_1 may be created by cooling through the critical temperature a restricted volume of U_4O_9 containing an entire dislocation in the UO_2 sublattice. Since in U_4O_9 the energy of antiphase boundaries depends little on its orientation the structure, it may leave the plane and become bent. If the dislocation is split into particles, the stacking fault and an antiphase boundary with the same displacement vector are superposed. The existence of extended dislocations and stacking fault ribbons in ordered and disordered U_4O_9 crystals implies that the stacking fault energy in UO_2 is drastically reduced by excess oxygen. (D.H.M.)

6889 GROUP IVB AND VB METAL CARBIDE–CARBON EUTECTIC TEMPERATURES. Adelsberg, L. M.; Cadoff, L. H.; Tobin, J. M. (Westinghouse Corp., Pittsburgh). J. Amer. Ceram. Soc., 49: 573-4(Oct. 21, 1966).

Techniques used to establish eutectic isotherms in these materials by thermal analyses and by isothermal anneal-metallography are described. Average eutectic temperatures are tabulated and compared with literature values. (J.R.D.)

6890 ALLOYING BEHAVIOR OF HfB_2 WITH URANIUM AND TRANSITION METAL BORIDES. Holleck, H. (Kernforschungszentrums, Karlsruhe, Ger.). J. Nucl. Mater., 21: 14-20(1966). (In German).

Phase boundaries in the ternary Hf–U–B system were delineated for the 1100°C section on the basis of x-ray examination in the temperature range 1100 to 1700°C. The ternary equilibria are: HfB_2–UB_{12}–UB_4; HfB_2–UB_4–UB_2; HfB_2–UB_2–(U, Hf) and HfB_2–HfB–(U, Hf), where the brackets represent saturated solid solutions. The mutual solubility of the diborides of the transition metals Ti, Zr, and Hf, and UB_2 is slight because of the considerable disparity in

c/a. The formation of mixed crystals between HfB_2 and the other transition metal diborides, and the mutual solubility of all these diborides, can be understood in terms of the size differences of the transition metal atoms. All binary systems with radius differences <14% have complete mutual solubility. The systems HfB_2-MoB_2 and ZrB_2-MoB_2, for which the radius difference = 14%, have partial and complete mutual solubility, respectively. All systems with a greater radius difference have a solubility gap. (auth)

Radiation Effects

Refer also to abstracts 6839 and 6872.

6891 (AECL-2521) IN-REACTOR THERMAL CONDUCTIVITY OF URANIUM CARBIDE. Tachis, A. M.; Mathers, W. G.; May, J. E. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Sept. 1966. 30p. Dep. mn. AECL $1.00.

Six plain natural UC fuel elements and one with four thermocouples were irradiated in the X-7 loop of NRX reactor. The sheathing material was SAP. The principal aim of the experiment was to determine the in-reactor thermal conductivity of UC which was found to be represented by the equation: $\lambda = 0.113\ (1 + 3.67 \times 10^{-4}\ T)$, where λ is the thermal conductivity in W/cm-°C and T is the temperature in °C. After the irradiation, the thermocouple element was destructively examined in the metallurgy caves. The results of the irradiation and of the examination of the fuel are given. (auth)

6892 (GA-7286) DESCRIPTION AND RESULTS OF THE P11 COATED PARTICLE IRRADIATION EXPERIMENT. Luby, C. S.; Chin, J.; Spillane, B. B. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 27, 1966. Contract AT(04-3)-167. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In the P11 capsule experiment, several types of improved coated fuel particles were irradiated at high temperatures (1170 to 1560°C) to 1 to 20% burnup (FIMA). Coated UC_2 particles and $(Th,U)C_2$ particles with different Th : U ratios (0 : 1, 0.4 : 1, 1 : 1, and 3 : 1) were used to achieve burnup rates of 15, 10, 7, and 4% per month, respectively. The fast-neutron-flux exposure was 4.7×10^{20} nvt (E > 0.18 MeV). The results of postirradiation examination indicate that (1) the Buffer-Isotropic (BISO) coated and the Triplex coated particles survive very high burnups (at highly accelerated burnup rates) at and above the anticipated temperatures of the HTGR, and that (2) burnup rate and irradiation temperature significantly affect the irradiation stability of coated particles. (auth)

6893 (GEAP-4897) IRRADIATION BEHAVIOR OF HYPER- AND HYPO-STOICHIOMETRIC PLUTONIA-URANIA FUEL AT 70,000 MWd/t. Zebroski, E. L.; Baily, W. E.; Hines, D. P. (General Electric Co., San Jose, Calif. Advanced Products Operation). Mar. 1965. Contract AT(04-3)-189. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two 20 wt% PuO_2 – 80 wt% UO_2 solid-solution fuel samples were irradiated in the GETR to a peak (radial average) burnup of 70,000 MWd/t. Two different stoichiometries of high-density fuel were irradiated in separate pins. The microstructure changes observed suggest a higher thermal conductivity in fuel with a slight oxygen deficit in comparison to fuel with excess oxygen. Fuel swelling causing up to 2 percent diametral expansion was noted in this experiment. Measurable fission gas porosity was noted in fuel sections that experienced burnups greater than 50,000 MWd/t and which operated at temperatures below 1600°C. This porosity was similar to that noted in earlier KAPL and Bettis experiments with UO_2. The porosity occupied about 15 percent of the total fuel cross section in the fuel that operated at 10 kW/ft. Cladding rupture was observed when the fuel had reached 70,000 MWd/t, apparently due to a local hot spot that occurred under a wire spacer. (auth)

6894 PREPARATION OF IRRADIATION TEST PELLETS OF $PuO_2-UO_2-ZrO_2$. Caldwell, C. S.; Fisher, F. D.; Roth, J. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 9: 544(Oct.-Nov. 1966).

6895 CALCULATION OF CREEP IN SPHERICAL PYROLYTIC-CARBON SHELLS UNDER COMBINED RADIATION DAMAGE AND INTERNAL PRESSURE. Prados, J. W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 382-3(Oct.-Nov. 1966).

6896 FACTORS AFFECTING GRAPHITE MODERATOR DISTORTION. Morgan, W. C. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 425(Oct.-Nov. 1966).

Plastics and Other Materials

Refer also to abstracts 6827, 6839, and 7861.

6897 (AD-635218) EFFECT OF TRANSISTOR DESIGN PARAMETERS ON RADIATION RESPONSE (POWER TRANSISTORS). Quarterly Technical Report No. 3, January 1–March 31, 1966. Honnold, Vincent R.; Thomas, Gary D.; Mazenko, Jerome J. (Hughes Aircraft Co., Fullerton, Calif.). July 1966. Contract DA-28-043-AMC-01541 (E). 21p. (ECOM-01541-3). CFSTI $1.00 cy, $0.50 mn.

The objective of the program is to determine particular design characteristics and fabrication techniques for a silicon planar power transistor that will minimize the effects of ionization and lattice displacements caused by high-energy radiation. Emphasis was placed on a digital computer program to perform an analysis of variance of the experimental data previously obtained and performing the irradiations on the first group of experimental devices. The experimental procedure used in conducting the neutron irradiation, the writing of the digital computer program and its checkout, and a sample analysis of variance at a low injection level are described. (auth)

6898 (LA-DC-8307) THERMAL DIFFUSIVITY OF PYROLYTIC GRAPHITE FROM 25 TO 1900 DEG C. Morrison, B. H.; Klein, D. J.; Cowder, L. R. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 15p. (CONF-661032-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 6th Conference on Thermal Conductivity, Dayton, Ohio.

The thermal diffusivity of pyrolytic graphite discs and hollow cylinders was measured from 25 to 1900°C by the flash technique. A ruby laser system was used as the pulsed energy source; a chromel–constantan–thermocouple and a photomultiplier tube detected the transient time-temperature response of a thin sample. Corrections for the heat loss and finite pulse time are included in the thermal diffusivity calculations. The data are compared with thermal measurements published by other laboratories. Problems inherent in thermal properties measurements of a highly anisotropic material are discussed. (auth)

6899 (N-66-32252) A STUDY OF POLYMERS CONTAINING SILICON–NITROGEN BONDS. Annual Summary Report, May 4, 1965–May 3, 1966. Burks, Robert E. Jr.; Covington, Edward R.; Ray, Thomas W. (Southern Research Inst., Birmingham, Ala.). Contract NAS8-20190. 160p. (NASA-CR-76654). CFSTI $3.00 cy, $0.65 mn.

The chemistry of Si–N compounds was studied to find routes to polymers that will be useful in aerospace technology. Two types of silphenylene polymers appear to be promising as sources of elastomers with good stability to heat and radiation. Coatings for Ti that were stable for more than 100 hours at 540°C (1000°F) were made from a silphenylene amine polymer and a methylphenyl silazane pigmented with Al. Silylamines also are effective curing agents for epoxy resins to produce polymers with good thermal stability, and they cure organic diisocyanates to resins, probably by a cyclization mechanism. Isocyanate polymers have been made with attractive physical properties at ordinary temperatures, but the combinations tried so far do not look promising for either high- or low-temperature applications. (auth)

6900 CRYOGENIC RADIATION DAMAGE IN STRUCTURAL POLYMERS. Funk, C. W.; Dixon, C. E. Trans. Amer. Nucl. Soc., 9: 406(Oct.-Nov. 1966).

6901 METHOD FOR PRODUCING FOAMED BODIES OF SYNTHETIC RESINS. Kanai, Masanori; Sagane, Norio (to Sekisui Chemical Co., Ltd.). Japanese Patent 1965-24387. Oct. 25, 1965. Filed Feb. 13, 1963.

A simple and convenient method is proposed for producing foamed bodies of synthetic resins with excellent thermal stability and high mechanical strength. The following materials are mixed together: one or more of the monomers selected from the group consisting of acrylamide, methacrylamide, acrylic acid, and methacrylic acid; a foaming agent in solid or liquid state at room temperature; a crosslinking agent having more than two polymerizable double bonds in a molecule; and any monomer, if necessary, that is copolymerizable with the monomers mentioned. The mixture is polymerized to the thermoplastic body containing the foaming agent homogeneously, and the plastic body is heated to a temperature above the softening point of the plastic in order to give, simultaneously, the foaming and the crosslinking reaction between the polymer molecules. Of the various polymerization methods such as polymerization with catalysts or initiators, thermal polymerization, radioinduced polymerization, photopolymerization, and ultrasonic polymerization, the radioinduced or the catalytic polymerization followed by irradiation gave the best results. (NSA of Japan)

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 6993, 7037, 7077, 7211, 7239, 7392, 7403, 7410, 7441, and 7443.

6902 (AD-636862) HYDROMAGNETIC MODEL FOR THE SOLAR GENERAL CIRCULATION. Scientific Report No. 1. Gilman, Peter A. (Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology). May 1, 1966. Contract AF 19(628)-5816. 221p. (AFCRL-66-316). CFSTI $3.00 cy, $0.65 mn.

Observations of phenomena on the surface of the sun of widely varying time and space scales are reviewed. Some of the theories for the larger, more slowly changing features are also surveyed. It is suggested that a plausible alternative to these theories could result from suitable hydromagnetic generalizations of the equations which have proved fruitful in understanding the earth's atmospheric general circulation. An energetically consistent set of scaled equations for large scale hydromagnetic flow is obtained and studied. The system is perturbed about a zonal flow and toroidal magnetic field. Some general integral theorems for unstable and neutral normal modes are proved. The stability of two level baroclinic flow in a uniform magnetic field is studied. This is generalized by adding parabolic flow in the upper layer. Qualitative and order of magnitude comparisons are made between the theoretical results and the solar observations showing enough consistency to encourage further work. (auth)

6903 (AD-637998) SOLAR PLASMA MEASUREMENTS. McCarron, J. D. (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). July 21, 1966. Contract AF 19(628)-5167. 25p. (TN-1966-26; ESD-TR-66-395). CFSTI $3.00 cy, $0.65 mn.

The existence of a corpuscular solar radiation which extends well into the solar system was proposed many years ago based on observations of geophysical phenomena. These early indirect observations of the solar plasma are reviewed and are compared to recent direct plasma measurements from ionospheric sounding rockets and from both geocentric and heliocentric satellites. Some of the measurement techniques employed in these direct observations are discussed in detail. (auth)

6904 (N-66-28208) SOLAR AND GEOPHYSICAL DATA, II. (National Physical Lab., New Delhi (India). Radio Propagation Unit). Feb. 1966. 17p. (RRC-A128(Pt.2)). CFSTI $3.00 cy, $0.65 mn.

Solar and geophysical data, recorded during January 1966, at the astrophysical observatory at Kodaikanal and at the radio propagation unit of the National Physical Laboratory in Delhi are presented. Tabulated data listed are: (1) geographical and geomagnetic latitudes and longitudes for the participating stations, (2) solar indices predicted sunspot numbers, (3) observed sunspot numbers, (4) optical observations of solar flares, (5) outstanding occurrences of solar radio emissions, (6) magnetic sotrms, and (7) ionospheric effects of solar flares (on frequency, noise absorption and fadeout, phase anomalies, and signal and atmospheric enhancements). Chart recordings of radio signal data are depicted. (STAR)

6905 (N-66-32181) DENSITY OF ZODIACAL DUST IN INTERPLANETARY SPACE. Rhee, John W. (Maryland Univ., College Park. Dept. of Physics and Astronomy). July 1966. 12p. (TR-581).

A further analysis of the Mariner II and the Mariner IV data seems to indicate that the particle number density varies from 10^{-16} to 10^{-14} particle per cm^3 and the spatial density ranges from 10^{-26} to 10^{-24} gram per cm^3 between 0.72 A.U. and 1.56 A.U. (auth)

6906 (NP-16422) ANISOTROPIC DIFFUSION OF SOLAR COSMIC RAYS. Burlaga, Leonard Francis (Minnesota Univ., Minneapolis. Cosmic Ray Group). Dec. 1966. 66p.

A mathematical model is presented and a relatively simple solution is obtained which describes the basic characteristics of solar cosmic ray propagation. The model postulates that solar cosmic rays diffuse anisotropically in the interplanetary medium because of the irregular spiral interplanetary magnetic field. It is assumed that the diffusion coefficient along the field direction is constant up to a distance r_1. It is assumed that beyond r_1, which is found to be approximately 2 AU for every event examined, the mean free path is essentially infinite, so that there is effectively a perfectly absorbing boundary at r_1. It is assumed that the diffusion coefficient perpendicular to the field lines increases with distance from the sun because of the diminishing magnetic field intensity. It is shown that the particles may be considered to be ejected instantaneously from the flare. The solution of the diffusion equation with these conditions shows that the shape of the intensity versus time profile and the time to maximum intensity depend on the position of the flare. It is shown that the data for several events for which unambiguous data are available are accurately described by this solution. It is demonstrated that the solution of the diffusion equation does apply during the anisotropic phase of several events. The model is consistent with several east-west effects which have been observed. (auth)

6907 (TID-23459, pp 7-14) RADIO ASTRONOMY. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

In order to investigate further the physical conditions responsible for the anomalously intense sources of 18-cm line emission at radio frequencies, an interferometric study was undertaken to determine the angular dimensions of the emitting regions. The interferometer was composed of the 84- and 120-ft antennas, with a baseline of approximately 3800 λ at 18 cm, along a line nearly 20° east of north. In a program of synthesis of discrete radio sources, the structures of many of these sources are being obtained by a variety of digital-computer processings, including smoothing, interpolation, inverse Fourier transformation, and model fitting. As part of a search on atmospheric spectral features, the planets Venus and Jupiter were observed from Jan. to March, 1966, at wavelengths near 1 cm. The observations were made with the 28-ft antenna and a five-channel microwave radiometer operating simultaneously at 19.0, 21.0, 22.235, 23.5, and 25.5 GHz. (W.D.M.)

6908 POSSIBILITY OF MAGNETOHYDRODYNAMIC EXPERIMENTATION IN ASTROPHYSICS. Shchegoleva-Svechnikova, G. P. Izv. Gl. Astron. Observ. Pulkovo, 24: 145-61(1965). (In Russian).

A review is given of experimental studies carried out with electroconductive fluids, applicable to astrophysics. The conclusion has been reached that the difference between the physical conditions in a laboratory and those in space greatly reduce the applicability of experimental results to space objects. Bibliography of 53 titles. (ATD)

6909 WOLF-RAYET STARS AND STARS RAPIDLY LOSING MASS. Tanaka, Yasuo (Tokyo Electrical Engineering Coll.). Progr. Theoret. Phys. (Kyoto), 36: 844-6(Oct. 1966).

Models are constructed for studying the mass loss and evolutionary sequence of stars. It is noted that the stars consist of a radiative envelope, in which the hydrogen content decreases toward the center, an intermediate radiative zone, and a convective homogeneous core. The luminosity and intensity of stars with high mass-loss rates are investigated and the results are discussed in relation to the Wolf-Rayet stars. (L.B.S.)

6910 TEMPERATURE DISTRIBUTION OF INTERSTELLAR H I GASES. Rohlfs, K. (Univ., Bonn). Z. Astrophys., 64: 487-503(1966). (In German).

The distribution function for the temperature of interstellar H I clouds was derived from an exact statistics of cloud collisions and a quantitative treatment of the cooling mechanisms. Two possibilities exist to obtain the observed value of the harmonic mean temperature: either there exist very powerful heating mechanisms for the interstellar gas with an energy output several orders of magnitude larger than those known until now, or the density of molecular hydrogen must be below $n(H_2) < 0.001\ n(H)$. (auth)

6911 STRUCTURE, OSCILLATIONS, AND STABILITY OF ROTATING WHITE DWARFS. Roxburgh, I. W. (London Univ.); Durney, B. R. Z. Astrophys., 64: 505-11(1966).

The internal structure of uniformly rotating white dwarfs was investigated within the framework of the general theory of relativity. The oscillation frequency and stability of these models was investigated by examining the behavior of small radial oscillations about the equilibrium state. It was found that rotation exerts a stabilizing influence on the star and an expression is derived to show the dependence of the oscillation frequency on the mass and angular velocity of the star. It was found that for maximum possible rotation velocity, so that centrifugal force balances gravity at the surface, then all stars with a mass greater than $(5.93/\mu^2)$ $M_\odot$ are unstable where μ is the molecular weight. (auth)

6912 CURRENT MOVEMENTS IN THE STABLE LAYER BELOW THE SOLAR HYDROGEN CONVECTION ZONE. Kohl, Klaus (Univ., Goettingen, Ger.). Z. Astrophys., 64: 472-86 (1966). (In German).

For a detailed model of the sun in the region $0 \leqq z \leqq 160{,}000$

km (z = geometrical depth counted downward in the vertical direction from the top of the atmosphere) the overshooting of the linear convective modes into the stable layers below the solar hydrogen convection zone was calculated, using the linearized hydrodynamic equations and including the effects of radiative transfer. The results are: (1) The strongest overshooting is obtained for fundamental modes with horizontal wave numbers $K \leqq 2\pi/d$ (d = thickness of the solar hydrogen convection zone). (2) The radiative exchange between rising and falling convective currents is not important for fundamental and first modes with $K \leqq 2\pi/d$ in the region $750 \leqq z \leqq 80{,}000$ km. (3) The mixing time for the stable zone below the solar hydrogen convection zone ($102{,}300 < z \leqq 160{,}000$ km corresponding to $8.76 \times 10^5 < T \leqq 1.22 \times 10^6$°K, is about 4.5 years. (auth)

6913 NEUTRON-PRODUCED ^{32}P IN THE BARWELL AND ST. SEVERIN METEORITES. Begemann, F.; Vilcsek, E.; Waenke, H. (Max-Planck-Institut fuer Chemie, Mainz). Nature, 213: 52-3(Jan. 7, 1967).

It is pointed out that there is very little direct information on the exposure of meteor material to fast neutron fluxes. The most sensitive indicator of fast neutrons is ^{32}P produced by $^{32}S(n,p)$ reactions, and determination of ^{32}P is interesting in this connection. Sulphur occurs in normal chondrites predominantly in the form of troilite and this mineral will contain the ^{32}P produced by the (n,p) reaction, in addition to that from the spallation of the iron in the iron sulphide. In the metal phase only ^{32}P produced by spallation is present. Separate analyses of the two phases should allow the two fractions to be distinguished. The analytical procedures adopted for the Barwell and St. Severin meteorites are outlined and results given. Some observed variations in results do not necessarily reflect a difference in intensity of the cosmic radiation, since the neutron flux at a given point is very sensitive to the pre-atmospheric size of a meteorite and the position of the sample within it. Production rates of ^{32}P from spallation of iron could not be assessed with any degree of accuracy, because of the small amounts of metal available and the low yield. Furthermore, as metallic nickel–iron is frequently found adjacent to troilite, an appreciable portion of the activity in the metal may be introduced by recoil of ^{32}P produced by the (n,p) reaction. (UK)

6914 HIGH ENERGY NEUTRONS FROM THE SUN. Daniel, R. R.; Joseph, G.; Lavakare, P. J.; Sunderrajan, R. (Tata Inst. of Fundamental Research, Bombay). Nature, 213: 21-3 (Jan. 7, 1967).

A balloon flight made from India has provided new evidence that energetic neutrons can be produced directly in solar flares. The emission of such neutrons and their detection near the earth could reveal the presence of fast charged particles in the coronal regions of the sun, and would also help to provide information concerning conditions on the sun at times of intense solar activity, free from the bias associated with the detection of fast charged solar particles near the earth. Investigations made from equatorial latitudes will have the advantage that the general background of neutrons produced by charged particles of galactic and solar origin will be a minimum. In the investigations described, a scintillator–spark chamber detector assembly was flown. The balloon reached a ceiling altitude of 11 mbar. The data not only provided positive evidence for the emission of high-energy neutrons from the sun, but indicated a plausible association between this and a sub-solar flare. The neutron emission lasted for at least 90 min, and appeared to pulsate with periods ≤ 10 min. (UK)

6915 THE LACK OF NEUTRAL HYDROGEN IN M5 AND M14. Heiles, Carl; Henry, Richard C. (Princeton Univ., N. J.). Astrophys. J., 146: 953-4(Dec. 1966).

Roberts (1960) speculated that interstellar neutral hydrogen might exist in globular clusters; but examination of the globular cluster M13 by Roberts (1959) and Goldstein (1964) showed that less than 150 $M_\odot$ of neutral hydrogen exist in this cluster. The results of observing the M5 and M14 clusters are presented. The equipment employed was the 300-ft transit telescope and the 100-channel autocorrelation receiver of the NRAO at Green Bank. Although no hydrogen appeared at the position of either cluster, an apparent concentration of hydrogen appeared in the summed scan for M5 at a different right ascension. (W.D.M.)

6916 X-RAYS FROM THE COMA CLUSTER OF GALAXIES. Felten, J. E.; Gould, R. J.; Stein, W. A.; Woolf, N. J. (Univ. of California, San Diego, La Jolla. Univ. of Texas, Austin). Astrophys. J., 146: 955-8(Dec. 1966).

An extended x-ray source of angular diameter 4 to 5° and spectral flux $j \approx 10^{-2}$ (cm^2 sec keV)$^{-1}$ at 25 keV centered at $\alpha \approx 13^h\,0^m$, $\delta \approx +28°$ has been reported. Assuming that the Coma Cluster identification is correct, it implies a surprisingly large x-ray luminosity for this cluster. These x rays might be produced in (a) individual galaxies within the cluster, or (b) the intergalactic medium. It is shown that (a) the superposition of individual galaxies probably cannot produce the observed flux and (b) the emission is accounted for by a mass of hot gas equivalent to the familiar missing mass suggested by application of the virial theorem to this cluster, provided $T \sim 10^{8.5}$°K. (W.D.M.)

6917 PHYSICAL CHARACTERISTICS OF SCO X-1. Johnson, Hugh M. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Astrophys. J., 146: 960-1(Dec. 1966).

Recent optical observations of the brightest x-ray source in Scorpius with previous x-ray data lead to a group of models. The models are presented as a function of radius R, starting with an upper limit of 10^{15} cm which corresponds to an upper limit of 1.3″ on the angular diameter at the probable distance of 100 pC. Six models are considered down to $R = 10^{10}$ cm. (W.D.M.)

6918 THREE-COLOR OBSERVATIONS OF SCORPIUS X-1, NOVA HERCULIS 1963, NOVA GK PERSEI 1901, AND MH α 328-116. Mumford, George S. (Tufts Univ., Medford, Mass. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 146: 962-4(Dec. 1966).

During the nights of Sept. 17 and 18, 1966 (U.T.), the 36-inch Cassegrain reflector at Kitt Peak was used for UBV observations of Sco X-1, MHα 328-116, Nova GK Persei, and Nova Herculis 1963. Observational data are summarized and mean values of the data are plotted. (W.D.M.)

6919 GALACTIC H(II) REGIONS AND THE LUMINOSITY OF THE GALAXY IN 12.8-MICRON RADIATION. Gould, Robert J. (Univ. of California, San Diego, La Jolla). Astrophys. J., 146: 944-6(Dec. 1966).

A rough estimate of the total luminosity $L_d(Ne^+)$ of the galactic disk due to the emission line Ne^+: $^2P_{\frac{1}{2}}$ (12.8 μ) radiated from interstellar H(II) regions was given earlier (Gould 1964). Using the revised value $\Omega = 0.32$ for the collision strength for excitation of this line (Osterbrock 1965), an earlier estimate by the author would be revised to $L_d(Ne^+) \sim 1 \times 10^{42}$ ergs/sec. In view of the importance of this number when used in estimating the cosmic intensity of the differential redshifted Ne^+ radiation from all galaxies in the Universe (Gould and Sciama 1964), a more careful calculation is made. (W.D.M.)

6920 ON THE ALPHA WIDTH OF THE 7.12-MeV STATE OF OXYGEN AND THE PRODUCTS OF HELIUM BURNING. Stephenson, G. J. Jr. (California Inst. of Tech., Pasadena). Astrophys. J., 146: 950-3(Dec. 1966).

Previous theoretical estimates have all been hampered by the inability of the models used to predict the requisite number of low-lying states. Brown and Green (1965, 1966) have discussed a model of ^{16}O which is free of this difficulty. To refine further the model by allowing for mixing between the bands projected from the different intrinsic states, these deformed states are identified with the SU(3) states of maximum weight as defined by Elliott (1958a, b) and by Elliot and Harvey (1963). In this notation the one-particle–one-hole state is identified with the {2,1} representation and the three-particle–three-hole state is identified with the {6,3} representation. (W.D.M.)

6921 ULTRAVIOLET, X-RAY, AND PARTICLE RADIATION OF THE SUN AND STARS. de Jager, C. (Rijksuniversiteit, Utrecht). Ned. Tijdschr. Natuur., 32: 156-70(May-June 1966). (In Dutch).

The present knowledge on the far ultraviolet and soft x radiation of the sun, the radiation of solar flares, particle radiation of the sun, the ultraviolet radiation of stars, and the x radiation of stars is summarized to indicate the knowledge that can be gained from satellite studies. (J.S.R.)

6922 THE ESCAPE OF LYMAN-LINE RADIATION FROM GASEOUS NEBULAE. Capriotti, Eugene R. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Astrophys. J., 146: 709-18(Dec. 1966).

Traditionally, the theoretical hydrogen radiation spectra of gaseous nebulae have been computed under the assumptions that all Lyman-line radiation for $n > 2$ either escapes the nebula or is destroyed in the nebula through self-absorption processes. Spectra computed under the assumption that there is partial leakage of Lyman-line radiation are presented. The results are that there is better agreement between the observations of planetary nebulae and theory when there is substantial leakage of Lyman-line radiation. However, in order to allow for substantial leakage of Lyman-line radiation, the optical depth in the continuum at the Lyman limit must be of the order of $\frac{1}{10}$ to $\frac{1}{20}$ while the accepted values are closer to unity. Estimates are made of the relative amounts of dust that must be present in the Orion Nebula in order to cause observable effects on the Balmer decrement through the destruction of Lyman-line radiation. It is found that the dust con-

centrations must be 10^2 to 10^4 times higher than those determined observationally in order that observable effects be produced. The effect of the scattering by dust close to the ionized regions of the Orion Nebula is investigated with the result that the observations and theory concerning the Balmer decrement can be made more compatible by including in the correction for reddening the effect of light being scattering into the line of sight as well as out of the line of sight. (auth)

6923 VARIATIONS IN THE RADIO-FREQUENCY SPECTRA OF 3C 84, 3C 273, 3C 279, AND OTHER RADIO SOURCES. Pauliny-Toth, I. I. K.; Kellermann, K. I. (National Radio Astronomy Observatory, Green Bank, Va.). Astrophys. J., 146: 634-45(Dec. 1966).

Seventy-eight nonthermal radio sources of small angular size, many of which have been identified with quasi-stellar objects, were observed at wavelengths of 40 and 22 cm and the results were compared with similar observations made three years earlier. Nine sources, 3C 120, 273, 279, 345, 418, and 454.3 and NRAO 140, 190, and 530, showed significant changes in their flux density at one or both wavelengths. The variations in 3C 84, 3C 273, and 3C 279 were studied in detail at 2, 6, 11, 22, and 40 cm. The observed changes in the radio spectra of these sources suggest the presence of very small components that are optically thick at cm wavelengths and have ages of only about 10 years. The energy requirements for 3C 84 and 3C 279 are discussed, and it is shown that in the case of 3C 279, if the radiation is due to synchrotron emission, the cosmological interpretation of the redshift requires the repeated production of more than 3×10^{58} ergs of relativistic electrons in times of 10 years or less. (auth)

6924 INTERPRETATION OF RADIO-SOURCE SPECTRA AND THE EVOLUTION OF RADIO GALAXIES AND QUASI-STELLAR SOURCES. Kellermann, K. I. (National Radio Astronomy Observatory, Green Bank, Va.). Astrophys. J., 146: 621-33(Dec. 1966).

It is known that radio galaxies and quasi-stellar sources (QSS) have spectral indices ranging from about −0.2 to −1.3 with a strong concentration near −0.75 to −0.80. It is shown here that this distribution may be readily explained if relativistic electrons which have an initial energy distribution $N(E) = KE^{-1.5 \pm 0.4}$ are injected into a magnetic field in a series of recurring bursts. Then at low frequencies, where electron energy losses due to synchrotron radiation and the inverse Compton effect are not important, the spectral index, α, is equal to its initial value of −0.25. At intermediate frequencies, the time scale for electron energy losses is stronger than the period between bursts and the injection can be considered to be quasi-continuous. The spectrum is thus in equilibrium since the electron energy losses are balanced by the injection of new particles. The spectral index is then steeper by ½ and becomes −0.75, which is close to that observed for the majority of sources. At higher frequencies, where radiation losses steepen the spectrum, the limiting index becomes −1.33, in good agreement with the observed cutoff near −1.3 in the spectral index distribution. If the source is observed soon after an outburst of relativistic particles, the high-frequency spectrum is dominated by the young electrons that have not yet decayed. The large positive curvature observed at centimeter wavelength in the spectra of several QSS and in NGC 1275, and the rapid variations in the radio and optical luminosity reported for these sources is interpreted as evidence of a recent injection of relativistic electrons. In some of these cases the density of particles is sufficiently great that the source is optically thick down to centimeter wavelengths, and the flux density increases rapidly with increasing frequency. Additional sources which do not have low-frequency components, such as Parkes 1934−63, might be discovered by an independent survey made at centimeter wavelengths. (auth)

6925 LUNAR OCCULTATIONS OF FIVE RADIO SOURCES. Taylor, J. H. Jr. (Harvard Radio Astronomy Station, Fort Davis, Tex.). Astrophys. J., 146: 646-52(Dec. 1966).

Lunar occultations of the radio sources CTA 21, 3C 17, 3C 132, 3C 444, and the Crab Nebula were observed at a frequency of 950 Mc with an 85-foot paraboloid antenna. Each immersion or emersion provided a one-dimensional brightness distribution of the occulted radio source, the limiting resolutions varying from 2 to 20 arc sec according to the size and strength of the source. The position of the point source CTA 21 was determined to within 1 arc sec; positions to within 8 arc sec and some limited structural information were derived for 3C 17 and 3C 132. Two-dimensional contour maps were constructed for 3C 444 and the Crab Nebula. (auth)

6926 RADIO OBSERVATIONS OF THE GALACTIC CENTER REGION. Downes, D.; Maxwell, A. (Harvard Radio Astronomy Station, Fort Davis, Tex.). Astrophys. J., 146: 653-65(Dec. 1966).

The galactic center region consists of a bright radio source, Sagittarius A, of angular diameter about 3.5 arc min, a number of weaker sources with dimensions of a few arc min, and an extended component about 1 arc deg in size. The intensity spectral index of Sagittarius A in the band 2 to 15 Gc is of the order −0.7, but at lower frequencies the existing evidence suggests that the index becomes positive. The evidence for regarding Sagittarius A as the galactic center is examined and the nature of the source, as revealed by its spectrum, is discussed. The other sources near Sagittarius A have intensity spectral indices of the order of −0.1 in the microwave band, indicative of thermal radiation from optically thin H(II) regions. (auth)

6927 DETERMINATION OF THE MICROWAVE SPECTRUM OF GALACTIC RADIATION. Penzias, A. A.; Wilson, R. W. (Bell Telephone Labs., Inc., Holmdel, N. J.). Astrophys. J., 146: 666-9(Dec. 1966).

Drift-curve observations of the galactic plane were made of 4080 Mc in five declinations selected for freedom from discrete sources. Comparison between the results of this work and previous work at lower frequencies yields a nonthermal spectral index of 2.9 (in temperature) in the range from 400 to 4080 Mc. (auth)

6928 REFLECTING AND OCCULTING OF GALACTIC RADIO ENERGY BY THE SUN AT 38 MEGACYCLES. James, Jesse C. (Center for Space Research, Cambridge, Mass.). Astrophys. J., 146: 670-85(Dec. 1966).

Solar occultation experiments are reported for which both Taurus A and the strong continuum along the galactic equator were used as the occulted sources. The occultation computations of Bracewell and Preston for a symmetrical corona are extended for a range of frequencies. Experimental results show that the corona does not always occult as though it were smooth and symmetrical, but the total occulted energy may be approximated with the smooth-corona theory. Computations of the mirrored energy in the corona are made, and some measurements of cosmic noise levels at 38 Mc are presented. (auth)

6929 THE CENTRAL DEPTH OF THE λ 6362 AUTO-IONIZATION FEATURE OF NEUTRAL CALCIUM IN STELLAR SPECTRA. Liller, William (Harvard Univ., Cambridge, Mass.). Astrophys. J., 146: 719-23(Dec. 1966).

Photoelectric measurements of the spectra of fifty late-type stars reveal that the central depth of the λ 6362 Ca I auto-ionization feature generally increases with decreasing stellar temperature. For the coolest stars measured, this central depth should be strongly luminosity-dependent. Stars with the highest radial velocities and with the weakest metallic lines seem to have a slightly weaker λ 6362 feature than do normal stars. (auth)

6930 LITHIUM IN CARBON STARS. II. Torres-Peimbert, Silvia (Univ. of California, Berkeley); Wallerstein, George. Astrophys. J., 146: 724-30(Dec. 1966).

The equivalent widths of the zero-volt lines of lithium and calcium for thirty-five carbon stars were obtained. From the ratio of the equivalent widths an index of the lithium-to-calcium abundance ratio was formed. The temperatures for most of the stars were estimated from photoelectric colors. Sixteen of thirty low-velocity stars show a substantial lithium content, and eleven other low-velocity stars probably have a lithium line present. On the other hand, all five high-velocity carbon stars show no lithium line at all. The low abundance of lithium in the high-velocity stars is understandable if their masses are low, but the origin of the substantial lithium content in the low-velocity stars remains unclear. (auth)

6931 PROFILES OF STRONG LINES IN TWO HYADES F STARS. Krishna Swamy, K. S. (Univ. of Chicago). Astrophys. J., 146: 731-7(Dec. 1966).

Two stars, 45 Tauri and HD 27808, in the Hyades Cluster were studied from an analysis of strong line profiles. The profiles studied are Hα, λ 3933 of Ca II, and λλ 5890, 5896 of Na I. The two stars give consistent results in showing that the metals in the Hyades stars are overabundant by a factor of about 1.5 with respect to the solar abundance. This is in conformity with the curve-of-growth study. (auth)

6932 AN INTERFEROMETRIC STUDY OF JUPITER'S DECIMETER RADIO EMISSION. Berge, G. L. (California Inst. of Tech., Pasadena). Astrophys. J., 146: 767-98(Dec. 1966).

An interferometric study of the decimeter radio emission from the planet Jupiter was recently carried out at the Owens Valley Radio Observatory. Using the two 90-foot paraboloids as an interference polarimeter, observations were made with various east–west spacings ranging from 300 to 4700 λ at 10.4 cm and 300 to 2300 λ at 21.2 cm and also with some critical north–south spacings at 10.6 cm. The visibility functions obtained are in agreement with earlier measurements, which gave the polar and equatorial di-

mensions as 1 and 3 planetary diameters, respectively, but they are more complete and extend to larger base lines. They permit the fitting of a rather detailed model for the decimeter brightness distribution. The observations are consistent with a symmetrical synchrotron emission source having the polarization properties one would expect with a dipole magnetic field. It probably is centered quite closely on the planetary disk, which is itself seen as a thermal radio source. The observations also indicate the presence of a small circularly polarized component in the radiation which varies in magnitude and sense as Jupiter rotates. The disk emission at 10.4 cm is about twice the thermal emission one would expect for a temperature of 130°K. The implications of the various results are discussed. (auth)

6933 OBSERVATIONS OF JUPITER, SATURN, AND MERCURY AT 1.53 CENTIMETERS. Welch, W. J.; Thornton, D. D.; Lohman, R. (Univ. of California, Berkeley). Astrophys. J., 146: 799-809(Dec. 1966).

Observations of the radio emission from Jupiter, Saturn, and Mercury at 1.53-cm wavelength are reported. The disk temperature of Saturn was found to be 0.94 times that of Jupiter at this wavelength. Mercury, observed at an average phase angle of 125°, was found to have a disk temperature three times that of Jupiter. With Jupiter's disk temperature assumed to be 150°K at this wavelength, the temperatures of Saturn and Mercury are 141° and 450°K, respectively. The similarity in the emission from Jupiter and Saturn at this wavelength can be explained if one supposes that ammonia gas is the chief source of microwave thermal radiation from both planets (due to the ammonia absorption band centered at 1.28 cm) and that the gas is saturated near the cloud tops of both planets. The possibility that emission from Saturn's rings may contribute to the ratio "disk" temperature of Saturn is briefly considered. If the particles in the ring are many centimeters in diameter and perfectly absorbing, the rings contribute about 25°K to the "disk" temperature. If their mean radius is about 300 μ, a probable size obtained by Franklin and Cook, their microwave extinction cross-section is small and the ring particles will not emit significant microwave energy. The high disk temperature of Mercury at large phase angles is in agreement with the observations of Howard, Barrett, and Haddock at 3.75 cm and Kellermann at 11 cm. With the radar determination that Mercury does not keep the same face to the Sun (Pettengill), these results can be understood if one supposes that the microwave emission from Mercury is similar to that from the Moon. On the other hand, the lack of disk temperature change with phase angle obtained by Epstein at 3.4 mm does not fit this interpretation. (auth)

6934 RELAXATION OSCILLATIONS IN HELIUM SHELL-BURNING STARS OF LOW MASS AND EVOLUTION INTO THE WHITE-DWARF STATE. Rose, William K. (Princeton Univ., N. J.). Astrophys. J., 146: 838-44(Dec. 1966).

A series of models were computed for stars with helium-burning shells and pure helium envelopes. Sufficiently evolved models are found to be thermally unstable, a circumstance that may have a significant influence on the subsequent evolutionary phases. The instability is similar to that discussed by Schwarzschild and Härm. The physical basis for the instability is discussed and the calculations for models with a mass of 0.53 $M_\odot$ are described. The models were tested for stability. The eigenvalues and eigensolutions associated with the instability were found; their behavior helps to justify the physical description of the instability. Solutions that follow the thermal instability were calculated, and the evolution of the star was carried to the white-dwarf state. It is suggested that the origin of planetary nebulae, as well as the occurrence of novae, may be connected with this instability. (auth)

6935 HELIUM STARS OF SMALL MASS. L'Ecuyer, Jean (Univ. of Chicago). Astrophys. J., 146: 845-57(Dec. 1966).

An evolutionary sequence of models is constructed for each of two stars of mass 0.5 $M_\odot$ and 0.7 $M_\odot$ initially made of pure helium. The whole lifespan from the helium-burning main sequence to the white-dwarf stage is covered. The Henyey method is used throughout with a special surface approximation; neutrino energy losses are excluded. The resulting paths in the H–R diagram are compared with that of the nuclei of planetary nebulae. There is also indication that the carbon and oxygen flashes do not exist, at least unless the neutrino energy losses drastically modify the situation. (auth)

6936 STUDIES IN STELLAR EVOLUTION. V. TRANSPORT COEFFICIENTS OF DEGENERATE STELLAR MATTER. Hubbard, W. B. (Univ. of California, Berkeley). Astrophys. J., 146: 858-70(Dec. 1966).

Quantum-mechanical Kubo expressions are employed to evaluate the electrical conductivity, thermal conductivity, and shear viscosity of a degenerate electron gas in the Lorentz gas approximation. The validity of the Lorentz gas approximation is discussed. The mean free path of the electrons is shown to depend upon the pair distribution function of the ions, and is evaluated analytically in the limit of ion weak coupling, and numerically for ion strong coupling. Agreement is obtained with previous theories of thermal conduction in degenerate stellar matter to within about an order of magnitude. (auth)

6937 STUDIES IN NON-GRAY STELLAR ATMOSPHERES. III. THE METAL ABUNDANCES OF SIRIUS AND VEGA. Strom, Stephen E.; Gingerich, Owen; Strom, Karen M. (Harvard Univ., Cambridge, Mass.). Astrophys. J., 146: 880-913(Dec. 1966).

The analyses presented for Vega and Sirius indicate that Sirius has many of the abundance anomalies characteristic of metallic-line A stars, while Vega has a chemical composition very similar to that deduced for the Sun. This investigation is based on a newly calculated, detailed grid of model stellar atmospheres that incorporates hydrogen-line blanketing and includes a range of metal opacities. Owing to their effect, of reducing the predicted Balmer discontinuity, the abundances of Si and Mg are shown to be important in the choice of appropriate models for A stars. The stellar-atmosphere grid used in conjunction with a careful abundance analysis very closely predicts the observed continuous spectra of Vega and Sirius and leads to reasonably self-consistent values of chemical composition. Moreover, the values of effective temperature, $T_{eff} = 9000° \pm 500°K$ for both stars, and surface gravity, $\log g = 4.0 \pm 0.2$ and 3.8 ± 0.2 for Sirius and Vega, respectively, obtained from this analysis, are in excellent agreement with independent measures of these parameters. (auth)

6938 CONTINUUM EMISSION FROM ROTATING NON-GRAY STELLAR ATMOSPHERES. II. Collins II, George W. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Astrophys. J., 146: 914-39(Dec. 1966).

The results of some calculations concerning the effects of rotation upon nongray early-type stellar atmospheres are presented. The results consist of forty-six spectral energy distributions for models having various masses, rotational velocities, and angles of inclination. The results are presented in the form of graphs of the monochromatic flux emitted by each model as well as tables of monochromatic magnitudes in units of wavelength and frequency, normalized to λ 5048. Additional tables contain the defining values of the models and the numerical value for the monochromatic flux at λ 5048. In addition, estimates of UBV colors and absolute magnitude M_v are given. The models considered include the same models for which Hβ line strengths have been calculated by Collins and Harrington. The variation of the parameters, T_e and g, which define the local atmosphere structure, is also discussed. The results are critically compared with contemporary work in the field. The possible application of this material to rotational studies of stars in OB associations is considered. It is found that disentanglement of V_e and $V_e \sin i$ is not possible on the basis of continuum studies alone. (auth)

6939 THE OPTICAL BRIGHTNESS VARIATIONS AND POLARIZATION OF THE QUASI-STELLAR RADIO SOURCE 3C 446. Kinman, T. D.; Lamla, E.; Wirtanen, C. A. (Univ. of California, Mount Hamilton). Astrophys. J., 146: 964-9(Dec. 1966).

3C 446 is one of a number of quasars of which direct photographs are being taken with the blue lens of the 20-inch Carnegie Astrograph for the purpose of detecting optical variations. The exposures were each of 1-hour duration on faked Kodak II aO emulsion with no filter. The plates were measured with a Sartorius astrophotometer using a photoelectric sequence of fourteen stars near the object. This sequence was observed with the prime-focus photometer of the 120-inch reflector on the Johnson BV system. Graphical data are given on the variation of the B magnitude and on the variation in V magnitude as a function of the position angle of the analyzer. (W.D.M.)

6940 ENHANCEMENT FACTOR AND TRUE ABSORPTION OF THE VHF COSMIC RADIO NOISE ASSOCIATED WITH SOLAR FLARES. Kim, J. S. (Univ. of Idaho, Moscow). Nature, 212: 1341-2(Dec. 17, 1966).

Some abnormal absorptions of cosmic radio noise at vhf are closely associated with solar flares and can be measured by means of riometers. If there is no enhancement of radio noise emission, the absorption of cosmic radio noise can be simply measured by comparison with a quiet day curve, but enhancement of radio noise at vhf frequently accompanies solar flares. The absorption measured by comparison with a quiet day curve would be quite different from the true absorption, and the enhancement of radio noise should be fully taken into account for the measurement of absorption. A method is described which can be best applied to flare-associated continuum emission (Type IV burst) which shows a prolonged, wide-band, relatively smooth enhancement of radio noise. (W.D.M.)

6941 SPECTRAL TYPES OF DECAMETRIC RADIATION FROM JUPITER. Riihimaa, J. J. (Inst. of Tech., Helsinki). Nature, 212: 1338-9(Dec. 17, 1966).

Experiments relating to the spectral fine structure of decametric radiation from Jupiter have been previously described. During the opposition of the planet in 1965 the high-resolution spectral experiment was repeated. The main equipment was the 14-channel spectrograph with channel-to-channel spacing of 50 kc and a frequency centered on 19.1 Mc. Some modifications were made to the antenna and display system so that the recording time constant was approximately 40 msec. The Helsinki Radio Astronomy Station spectrograph was operated for 3 to 4 hours each night from October 1 to December 31, 1965. The new results support the earlier ones. (W.D.M.)

6942 ROLE OF ACCELERATION IN RELATIVISTICALLY EXPANDING OBJECTS AND ITS SIGNIFICANCE FOR THE INTENSITY VARIATIONS IN QUASI-STELLAR SOURCES. Narlikar, J. V. (King's Coll., Cambridge, Eng.). Nature, 212: 1337-8 (Dec. 17, 1966).

Rees has discussed the appearance of relativistically expanding objects as seen by distant observers, with a view to explaining the variation of flux from radio sources. He considers a spherical shell expanding with a uniform radial velocity $v \sim c$. The apparent radius of the source at time to, measured from the moment when the expansion is seen to begin, is $\gamma v t_0$, where $\gamma = (1 - v^2/c^2)^{-\frac{1}{2}}$. The Doppler blue shift, measured at the ratio of frequency observed to frequency emitted, varies from γ on the limb to $\gamma[1 + v/c]$ in the center. The effect of special relativity in Rees's model is to cut down the apparent time scales, in the cases where γv is greater than c. The actual variation of flux is obtained from an astrophysical model. Such a model might work for radio variations, but not for optical variations of quasars. The effect of acceleration in a relativistically expanding object is pointed out. The calculations show that the front part of the object has a rapidly rising blue shift which could cause a sudden rise in the observed intensity of the source. Since this is a pure Doppler effect it could work in optical as well as radio-frequency range. (W.D.M.)

6943 ANGULAR SIZES OF QUASI-STELLAR RADIO SOURCES. Hogg, D. E. (National Radio Astronomy Observatory, Green Bank, W. Va.). Nature, 212: 1336-7(Dec. 17, 1966).

In a recent survey with an interferometer at 2,695 Mc, it was found that most of the quasars which have large fluxes at this frequency are unresolved, indicating sizes which are less than 3″. The survey has now been extended to include all objects in Wyndham's list that are possible quasars, as well as a few other sources with well established identifications. Most of the sources in the second survey have smaller fluxes and are resolved, with sizes ranging from 5″ to 70″. The observations were made with the two-element interferometer of the NRAO, operating at 2,695 Mc with a spacing of 16,000 wavelengths. (W.D.M.)

6944 INVERSE COMPTON EFFECT IN QUASI-STELLAR SOURCES. Hillier, R. R. (Univ. of Bristol, Eng.). Nature, 212: 1334-6(Dec. 17, 1966).

Hoyle, Burbidge, and Sargent have discussed a model of the quasar, 3C 273B, in which the optical emission is synchrotron radiation from relativistic electrons moving in a magnetic field. Some of the synchrotron photons will interact again with the relativistic electrons through the inverse Compton effect and their energy will be increased. It is shown that the Compton losses can be greater than the synchrotron losses and that there need be no divergence in the power radiated. This model of a quasar does, however, impose restrictions on the source of the relativistic electrons. (W.D.M.)

6945 RELATION BETWEEN THE RED-SHIFTS OF QUASI-STELLAR OBJECTS AND THEIR RADIO MAGNITUDES. Hoyle, F. (Cambridge Univ., Eng.); Burbidge, G. R. Nature, 212: 1334 (Dec. 17, 1966).

In a previous letter it was shown that in a sample of thirty identified quasars no sensible correlation exists between red shifts and radio fluxes S, though a plot of log N – log S gives a slope compatible with the usual radio source counts. It was therefore stated: "Thus if the usual distance–volume interpretation of the result $NS^{\frac{3}{2}} \approx$ constant is adopted, it must be concluded that the red shifts have nothing to do with the distance." A number of criticisms to this statement are listed and briefly discussed. (W.D.M.)

6946 OBSERVATIONS OF THE CARINA NEBULA (NGC 3372) AT 1410 AND 2650 Mc/s. Beard, M.; Kerr, F. J. (CSIRO, Chippendale, Australia). Austral. J. Phys., 19: 875-81(Dec. 1966).

The 2650 and 1410 Mc/s isophotes of an area of approximately 4 sq deg centered on the Carina nebula are presented. The aerial beamwidth of 7′.4 at 2650 Mc enables a useful comparison to be made with Hα photographs of the region taken at Mount Stromlo. No evidence of nonthermal radiation was obtained and a spectral index of +0.1 was measured. (auth)

6947 RADIO EMISSION OF THE NUCLEI OF BARRED SPIRAL GALAXIES. Tovmassian, H. M. (CSIRO, Chippendale, Australia). Austral. J. Phys., 19: 883-92(Dec. 1966).

The results of radio observations of 98 barred galaxies at 11, 21, and 75 cm are presented. The observations were carried out with the 210-ft radio telescope of the Australian National Radio Astronomy Observatory and with the Mills Cross of the Sydney University Molonglo Radio Observatory. Radio emission originating within 1.5 minutes of arc of the center of corresponding galaxies was detected in 21 cases. It is concluded that the central parts of galaxies (possibly their nuclei) are responsible for the radio emission. Spectral indices of detected sources were determined. Radio indices show that radio emissivity of the majority of the investigated galaxies is higher than that of normal galaxies. (auth)

6948 PARKES CATALOGUE OF RADIO SOURCES: DECLINATION ZONE 0 DEG TO -20 DEG. Shimmins, A. J. (CSIRO, Chippendale, Australia); Day, G. A.; Ekers, R. D.; Cole, D. J. Austral. J. Phys., 19: 837-74(Dec. 1966).

Details are given of 628 radio sources between declinations 0° and −20° compiled from observations made at 408 Mc with the 210-ft reflector at the Australian National Radio Astronomy Observatory, Parkes, N.S.W. The survey covers an area of 1.87 steradians, omitting the regions near the galactic plane. Additional measurements of flux density and position were made at 1410 and 2650 Mc. Some discussion on spectra, source counts, and source identification is included, and a comparison is made between this survey and other published catalogs covering the same region. (auth)

6949 CYCLOTRON RADIATION FROM ELECTRON STREAMS AS THE ORIGIN OF SOLAR TYPE I NOISE STORMS. Fung, P. C. W.; Yip, W. K. (Univ. of Tasmania, Australia). Austral. J. Phys., 19: 759-93(Dec. 1966).

Cyclotron radiation from electron streams gyrating in some spot-field configurations in the corona is proposed to be the origin of solar type-I noise storm radiation. In order to investigate whether one or both of the characteristic waves (ordinary and extraordinary modes) will carry significant electromagnetic energy and be observed, the power spectra from single electrons, the process of amplification of electromagnetic waves in a stream–plasma system, the power loss due to harmonic resonance absorption, and the escape conditions were studied for two characteristic modes. It was found that in most cases the radiation in the o-mode was predominant. With two types of solutions in the simultaneous solution of the Appleton–Hartree equation and the Doppler equation, both the occurrence of narrow-band burst emissions and wide-band continuum radiation can be explained by the cyclotron generating mechanism. Moreover, many of the observed features are found to agree well with the predictions of the theory. (auth)

6950 THEORY ON THE CREATION OF STELLAR MAGNETIC FIELDS. Cattani, D.; Sacchi, C. (Univ., Bologna). Nuovo Cimento (10), 46B: 258-72(Dec. 11, 1966).

A theory is put forward which explains the generation of a poloidal magnetic field in a star. This theory is not founded on any hypothesis "ad hoc," but only on the braking effect of radiation on the rotation and on other very plausible conditions. When it is applied to the sun it gives, in an infinite time, a uniform field of about 10^{-3} gauss. By means of a cylindrically symmetric model it is shown that the field may rise to 10^{-1} gauss in a time of the order of 5×10^9 years and that, for times smaller than this, the field increases as $t^{\frac{1}{2}}$. For magnetic stars the theory gives a field 10^3 to 10^4 times greater than that found for the sun. Because these fields are one thousandth of the observed ones they are considered as "seed" fields which must be amplified in some way. A simple dynamo mechanism in which amplification is obtained through radial oscillations of the layers which confine with the photosphere is outlined. Limiting the amplified field to the low-conductivity photospheric regions, low growth time and inversion of polarities should be possible. The proposed theory seems to be incompatible with the oblique-rotator theory and rules out the necessity of postulating primeval magnetic fields. (auth)

6951 STUDY OF THE b TRIPLET OF MAGNESIUM IN THE DISK AND THE CHROMOSPHERE. Henoux, J. C. (Observatoire de Paris, Meudon, France). Ann. Astrophys., 29: 271-86(May-June 1966). (In French).

Determination of the b line profiles is reported, as observed in the chromosphere at Sacramento Peak Observatory. The line profiles were corrected for atmospheric and instrumental blurring and scattering. Variations of the empirical source function, assumed to be the same for the three b lines, and of the Doppler width with the optical depth τ_0 in the center of the b_1 line, were inferred from the Waddell's Mg b lines from limb darkening data. The value obtained for the Doppler width was constant, $\Delta\lambda_D =$

38 mÅ. Intensities of the extreme core of Mg b line profiles ($v < 2.5$) are calculated on the basis of the $S(\tau_0)$ and $\Delta\lambda_D(\tau_0)$ variations previously obtained, and are compared with the observed ones. Representation of the profiles was good but there were some differences for $\mu < 0.4$ and $v > 1.2$. The chromospheric profiles were calculated on the basis of the $S(\tau_0)$ and $\Delta\lambda_D(\tau_0)$ variations. The representation of the extreme core was good, but important differences between the calculated and observed profiles appeared when $v > 3$, as well as a disagreement between the House's value for the scale height, inferred from the observation of the intercombination line $\lambda = 4571$, and the present H value. It is concluded that it is not possible to obtain an accurate description of the observations as long as the hypothesis of spherical symmetry is employed. (BBB)

6952 TESTS OF THE HYPOTHESIS OF A MARKOV CHAIN. APPLICATION TO THE SUCCESSION OF VARIOUS TYPES OF EXPLOSION OF SS CYG. Lortet-Zuckermann, M. C. (Institut d'Astrophysique, Paris). Ann. Astrophys., 29: 205-22(May-June 1966). (In French).

Whether the time sequence of the various types of thermonuclear explosions of the star SS Cyg may be considered as a simple Markov chain, as has been suggested by Martel, is discussed. General aspects of various questions related to Markov chains are examined on the basis of the definition and classical properties of a simple Markov chain and of a chain of arbitrary order. Other less known properties are considered, and several tests found in the literature which apply to instances in which the observed process is known to be a Markov chain are cited. Whether this chain is specified by certain parameters is considered, and some new tests are proposed which apply to the study of an observed process of which it cannot be said a priori whether or not it may be represented by a Markov chain. These tests are of interest in that they may be applied to relatively short samplings, and, in certain cases in which other tests are inconclusive, they make it possible to reject the Markov chain hypothesis. Also examined is the time sequence of the various sorts of explosions of SS Cyg. Explosions of this star are classified in 3 categories: long, short, and very weak explosions. The sequence of the 444 explosions observed from 1896 to 1957 are discussed. The sequence of long (L) explosions and of not-long explosions (E) is fairly well represented by a simple Markov chain. This essentially is a consequence of the tendency of these 2 sorts of explosions to alternate in SS Cyg. The sequence of very weak (A) explosions and of other (B) explosions is well represented by a second-order Markov chain. The same is true of the sequence of long (L), short (C), and very weak (A) type events. However, the Markov chain scheme of first, second, or higher order is not satisfactory because it can explain neither the very large number of cycles of 3 explosions, nor the existence of irregular periods which are evident in very weak explosions and rare in long explosions. It is concluded that, in general, the Markov chain scheme is poorly adapted for representation of the sequence of the various types of explosions of the SS Cygni stars. As a better and physically more realistic scheme, the recurrent event process is proposed. (BBB)

6953 THERMOMETRY OF SUN'S INTERIOR IN NEUTRINO EXPERIMENTS. Kuzmin, V. A (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR, 167: 1276-9(Apr 21, 1966). (In Russian).

A review of the literature and calculation and extrapolation of data indicate the upper limit of the sun's internal temperature to be $(18 \pm 2) \times 10^6$. The conclusions are based on solar neutrino effects, this flux being a function of the internal temperature. The reactions involved are, for a high-threshold detector, chiefly the $^8B(e^+,\nu)^8Be$ reaction although the reactions $^{13}N(e^+,\nu)^{13}C$, $^{15}O(e^+,\nu)^{15}N$, and $^7Be(e^-,\nu)^7Li$ also occur. High-threshold detectors are ^{37}Cl, detectors of electrons produced in such reactions as $\beta-^2H$ or $\beta-^7Li$, and recoil electrons from scattering processes, e.g., $\nu + e^- \rightarrow \nu + e^-$. With low-threshold detectors, e.g., ^{71}Ga, the effect is due to the reactions $^7Be(e^-,\nu)^7Li$, $^1H(p,e^+,\nu)^2H$, and, in very hot models, $^{13}N(e^+,\nu)^{13}C$ and $^{15}O(e^+,\nu)^{15}N$. (TTT)

6954 INVERSE COMPTON EFFECT: SOME CONSEQUENCES FOR QUASARS. Pfleiderer, J.; Grewing, M. (Univ., Bonn). Science, 154: 1452-3(Dec. 16, 1966).

The inverse Compton effect can transform enough energy of relativistic electrons into radiation so that an upper limit to the mean energy of the electrons is set. In quasars, the limit is too small to allow the production of any appreciable amount of synchrotron or inverse Compton radiation, unless either the distances are not cosmological or the lifetimes of the relativistic electrons are extremely short, of the order of hours. (auth)

6955 POSSIBILITY OF MASER ACTION IN COSMIC RADIO SOURCES. McCray, Richard (Space Science Center, Los Angeles). Science, 154: 1320-3(Dec. 9, 1966).

A mechanism is described for maser action in synchrotron sources. The process may contribute to the low-frequency radiation from 3C 273B. (auth)

6956 HIGHLY SYMMETRICAL PATTERN IN THE CONTINUUM EMISSION FROM THE GALACTIC CENTER REGION. Kerr, F. J.; Sinclair, M. W. (CSIRO, Sydney). Nature, 212: 166-7(Oct. 8, 1966).

A new continuum survey of the galactic central region was carried out at 20 cm with the Parkes 210-ft telescope. A total area of 60 square degrees was covered. Attention is directed to a highly symmetrical structure in the vicinity of the center. (W.D.M.)

6957 IRREGULARITIES IN THE SOLAR ATMOSPHERE. Das Gupta, M. K.; Basu, D. (Univ. of Calcutta). Nature, 212: 168-9(Oct. 8, 1966).

An attempt was made to determine the fine structure of the solar atmosphere with the help of recent radio data. The analysis was made using solar radio noise data at different frequencies for the period 1958 to 1964. The pairs of frequencies selected were 600/1,000 Mc, 1,000/2,000 Mc, 2,000/2,800 Mc, and 2,800/3,750 Mc. The region covered by these frequencies includes the chromosphere as well as the base of the corona. (W.D.M.)

6958 QUASI-STELLAR OBJECTS: POSSIBLE LOCAL ORIGIN. Terrell, James (Los Alamos Scientific Lab., N. Mex.). Science, 154: 1281-8(Dec. 9, 1966). (LA-DC-7833).

Various difficulties are removed by the hypothesis that the observed quasars were ejected from a gravitational collapse at the center of our own galaxy, which may have occurred roughly 5 million years ago. The resultant distances, of the order of a million light years, reduce the energy problem by a factor of 10^6 or 10^7. On this basis the optical diameter would be less than a light hour, about the size of the earth's orbit. A rotating mass of a few thousand solar masses with this diameter would account for the unusual line width, could easily produce the required radiated energy, and could readily account for observed short fluctuation periods and variations in spectrum. (W.D.M.)

6959 ASCENT AND DESCENT IN THE EIGHTY-YEAR CYCLES OF SOLAR ACTIVITY. Gleissberg, W. J. Brit. Astron. Ass., 76: 265-8(June 1966).

Analysis is made of the ascent and descent in the 80-year cycles of solar activity based on Schove's decadal numbers of auroral frequency. It is found that the longer the period of ascent, the higher is the ascent and, conversely, the longer the period of descent the deeper the descent. The mean lengths of the period of ascent and descent are 38 and 41 years, respectively. (Int. Aero. Abstr.)

6960 EXTENSION OF THE SPECTRUM OF SINGLY IONIZED YTTRIUM IN THE SUN. Swensson, J. W. (Univ., Liege. Univ., Lund, Sweden). Observatory, 86: 123-5(June 1966).

Bovey's data on the yttrium Fraunhofer spectrum are extended to the 7948 to λ 12016 range based on measurements of the original Jungfraujoch tracings. A table is presented which indicates the lines of strongly ionized yttrium in the IR solar spectrum, the first four columns of which contain Bovey's data. The remainder of the table contains solar data, including computed wavelengths and a comparison of these values with the observed laboratory and solar wavelengths. (Int. Aero. Abstr.)

6961 EMPIRICAL DECISION POSSIBILITIES CONCERNING THE NATURE OF QUASI-STELLAR OBJECTS. Barnothy, J. M. (Biomagnetic Research Foundation, Evanston, Ill.). Astron. Nachr., 289: 127-8(1966). (In German).

A discussion is presented of some empirical decision-making techniques which make it possible to determine whether a quasi-stellar source (QSS) or quasi-stellar galaxy (QSG) is a superluminous object or an image produced by a gravitational lens. The evolutionary, Bondi–Gold, and Fib models of the universe are considered. (Int. Aero. Abstr.)

6962 INVESTIGATIONS ON TYPE III/V BURSTS OF SOLAR RADIO EMISSION. I. PHENOMENOLOGY AND PROPERTIES OF TYPE V BURSTS. Daene, H. (Astrophysikalisches Observatorium, Deutsche Akademie der Wissenschaften, Potsdam, Ger.); Krueger, A. Astron. Nachr., 289: 105-15(1966).

The phenomenological features of type-V radiation are discussed as the basis of fine structure records taken at the Potsdam Astrophysical Observatory since 1958. A phenomenological subclassification is derived from the various forms of appearance. It is believed that significant qualities are only the longer duration than that of normal type-III bursts and the fact that nearly always a type-III burst is preceding. It seems that there are no urgent reasons to consider type-V emission as continuum radiation. It is assumed that no different excitation mechanism is effective for type-III and type-V. The observational facts are tentatively explainable by special assumptions about the structure of the exciting electron stream. Additionally it is taken into consideration that the

prolonged duration of type V is due to a merging process. It is suggested that merging occurs if the same coronal area is reexcited by a second electron stream, whereas superposition occurs if different areas are excited by both the streams. The possibility is considered that harmonics partly contribute to the observed features. (auth)

6963 INVESTIGATIONS ON TYPE III/V BURSTS OF SOLAR RADIO EMISSION. II. RELATION TO THE FLARE EVENT. Daene, H. (Astrophysikalisches Observatorium, Deutsche Akademie der Wissenschaften, Potsdam, Ger.); Krueger, A. Astron. Nachr., 289: 117-26(1966).

Decameter type-III and type-III/V bursts observed during more than five years are investigated statistically concerning their association with microwave bursts and chromospheric flares. The effects of starting times, morphology, and spectrum of associated microwave bursts are discussed as well as the importances and positions of the correlated flares. Distributions of starting frequencies of some classes of type-III bursts have been taken into account. The primary origin of type-III bursts has been supposed to be within or a little above those levels of the solar atmosphere, where the bursts of the lower-decimeter range originate. The occurrence of type-V bursts is not characteristic for the frequency of disappearance of type-III bursts as a consideration of the "ending" frequencies of type-III bursts shows. (auth)

6964 DISCRETIZATION IN GALACTIC STRUCTURE AND COSMOLOGY. Thomas, T. Y. (Indiana Univ., Bloomington). pp 389-412 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

The groundwork is presented of a relativistic theory for the explanation of the discretization effects in the structure of galaxies which have been disclosed by the recent investigations of A. G. Wilson. The basic assumption, which is referred to as the principle of similarity, expresses in invariant differential form the well known geometrical concept of the similarity transformation, and leads to metrics which appear to be somewhat more general than those in common use in cosmological theory. This principle also leads to the introduction of a wave function ψ which can be interpreted as directly representative of the deviations from a statical metric that occur within the galaxian world tubes or on their boundaries as the result of the action of extraneous influences. It is found that certain discretization effects are required for the existence of solutions of the wave equation satisified by the function ψ under steady state conditions; this is discussed briefly for the special case of spherical galaxies. (auth)

6965 NEGATIVE MASS AND THE QUASARS. Hoffmann, Banesh (Queen's Coll., Flushing, N. Y.). pp 176-83 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

One can exclude negative mass from the general theory of relativity or the quantum theory only by an ad hoc assumption extraneous to those theories. The general theory of relativity, however, is not symmetric between positive and negative mass: in particular, there is evidence that gravitational radiation has positive definite energy whether its source has positive or negative mass. Based on this asymmetry, a physical process is proposed whereby negative mass could be generated inside quasars, thus helping to account for their prodigious energy outputs. Negative mass, if it exists, would tend to collect in the interiors of stellar objects, and this could account for its not having been observed. It might, however, be detected in cosmic-ray experiments. (auth)

6966 CLASS OF MODEL UNIVERSES SATISFYING THE PERFECT COSMOLOGICAL PRINCIPLE. Ellis, G. F. R.; Sciama, D. W. (Cambridge Univ., Eng.). pp 150-60 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

It is shown that there exist anisotropic expanding model universes satisfying the Perfect Cosmological Principle (PCP). The advantages of introducing such anisotropy are pointed out. In particular, there are such models in which the Ricci tensor has a unique timelike eigenvector, which might represent the velocity of matter (in contrast to the conventional de Sitter representation of PCP). Among these models are some which are globally isotropic (so that a locally preferred direction does not appear to an observer as a globally preferred direction), and which have nearly the same expansion rate in all directions (so that the model is physically realistic). (auth)

6967 OSNOVY KOSMICHESKOI ELEKTRODINAMIKI. (Fundamentals of Space Electrodynamics). (2nd Edition). Pikelner, S. B. Moscow, Izdatelstvo Nauka, 1966. 408p.

This book is intended for the general reader interested in the application of magnetohydrodynamics to astrophysics. The chapters include: general properties of a plasma; interaction of a magnetic field with a moving conducting medium; waves in plasma; questions of stability; certain forms of motion of a continuous medium; magnetohydrodynamics of stars and the Galaxy; and solar magnetohydrodynamics. Mathematics is held to the necessary minimum. This second edition contains supplementary material on the divergence of a plasma from the equilibrium state, nonlinear waves, collisionless shock waves, and particle acceleration. Consideration is given to the more recently developed techniques for investigating the magnetic field of the Galaxy, the formation of spiral arms and other structural details, galactic explosions, motions in the solar atmosphere, the nature of solar active regions, and new data on the interaction of the earth with the solar wind. (Int. Aero. Abstr.)

6968 APPLICATIONS OF ELEMENTARY PARTICLE PHYSICS TO ASTROPHYSICS. Inman, Cullen Langdon. New York, New York Univ., 1965. 72p.

Thesis.

Possible astrophysical consequences of, and limits for, a magnetic dipole moment of the muon's neutrino are considered. The weak induced magnetic dipole moment of the muon's neutrino and the integrated μ-neutrino luminosity for certain stellar models are calculated. Masses, radii, and total baryon number for a number of values of the central density of baryon star models are obtained. (TSS)

6969 GRAVITATIONAL RADIATION IN A STATIC STEADY-STATE COSMOLOGY. Ingerson, Thomas Edgar. Boulder, Colo., Univ. of Colorado, 1965. 181p.

Thesis.

There are two arguments generally advanced to show that the universe is expanding. One argument is that it has been shown that there are no possible solutions for the Einstein field equations which allow a static universe to be stable. The other argument is that objects in the universe exhibit a general red shift of their spectral lines as a function of their distance from the earth. This shift is widely believed to be a Doppler shift, and is interpreted as evidence of a general expansion of the universe. It is shown that the argument proving that there are no stable static solutions of the Einstein field equations rests on an interpretation of the physical meaning of one of the terms in these equations. It is shown that there is at least one other possible interpretation of the meaning of this term which is consistent with experiment. This interpretation leads to the conclusion that the equations allow the possibility of a static and stable universe. It is also shown that the interpretation of the red shift as a Doppler shift is not necessary, and that classic conservation laws indicate strongly that a red shift must occur as a result of gravitational radiation. Several approximate methods are used to calculate this radiative red shift, including a specific calculation of the energy in the radiation using the Einstein pseudotensor method. These approximate methods yield slightly different results for the magnitude of the red shift, but this is because they are approximations. The equations cannot be solved in general at present. All methods indicate the existence of a red shift consistent with the experimental evidence available. It is shown that a cosmology of a non-expanding type may be constructed using these two new arguments, and that this cosmology is at least as consistent with the experimental evidence available as the theories of expanding universes. It is therefore proposed that this cosmology must be considered in attempting to determine the true cosmology of the universe. In addition, an iterative method of solving the Einstein field equations is demonstrated, and the gravitational radiative red shift of a pulse of light passing a point mass is calculated. (Dissertation Abstr.)

6970 COSMIC X-RAY SOURCES. Tucker, Wallace Hampton. San Diego, Calif., Univ. of California, 1966. 127p.

Thesis.

The emission from a hot, low density plasma due to bremsstrahlung, radiative recombination, and electron collision-induced line emission is calculated. Results are given for the total energy emission rate as a function of temperature and also for the emission in the region 2−8Å, which is the principal region of sensitivity for the detectors in x-ray rocket experiments. The emission spectrum from such an optically thin plasma is given. This spectrum has a number of strong emission lines. If the observed cosmic x-ray sources are actually hot, low density gases, these lines should be detectable. It is found that significantly different line intensities are obtained for a gas having the cosmic abundances and one having the composition estimated for a supernova envelope. These calculations are used to estimate the x-ray flux to be expected from a number of objects, as well as to interpret the observational data on discrete x-ray sources. Among other things, it is found that, whereas several objects might be expected to emit observable quantities of hard radiation, only the supernova hypothesis seems capable of explaining all the data on the strong

source in Scorpius. The synchrotron hypothesis for the x-ray source in the Crab Nebula is examined with the aid of a kinetic equation for the electron energy distribution function, and several models which explain the radio, optical, and x-ray emission are proposed. (Dissertation Abstr.)

Atomic and Molecular Physics

Refer also to abstracts 6357 and 6951.

6971 (AD-633670) STUDY OF THE PROTECTIVE EFFECT OF A THIN FILM ON A SURFACE EXPOSED TO SPUTTERING. Parker, Robert Kelley (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Mar. 1966. 157p. (SP-PH-66-15). CFSTI $3.00 cy, $0.65 mn.

Thesis.

A serious problem in the design of plasma devices has been the erosion of material surfaces in contact with an energetic plasma. A technique for the protection of surfaces exposed to the destructive effects of sputtering was investigated. The technique involves the coating of a metallic substrate (tantalum) with a thin protective film of gallium. Although no quantitative measurements of the protective effect were obtained, the existence of the protective effect was definitely established. The effect was found to be substantial at ion energies near the threshold potential. However, the effect was found to have an upper limit near or below 100 eV. This protective effect would have its best application under conditions of high current density and low bombardment energies. (auth)

6972 (AD-636598) STUDY AT HIGH ENERGY-RESOLUTION AND AT LOW PRIMARY ENERGIES OF THE SECONDARY ELECTRON EMISSION FROM (100) TUNGSTEN. Report No. R-304. Piper, Thomas C. (Illinois Univ., Urbana. Coordinated Science Lab.). July 1966. Contract DA-28-043-AMC-00073(E). 120p. CFSTI $3.00 cy, $0.65 mn.

An apparatus was designed and constructed to study secondary electron emission at low primary energies (0 to 50 eV). Secondary energy distribution and elastic and inelastic reflection data are presented for primary electrons incident on both clean and gas-covered (100) tungsten. Structures in the elastic and inelastic reflection data were found to be associated with the band structure of the target. Discrete energy loss structure due to the excitation of vibrational levels of gas complexes adsorbed on the target was found in the region just beneath the elastic peak for primary energies between 1.0 and 10.0 eV. Various adsorbed gases were found to give rise to different spectra of discrete energy losses. The constant shape and location of the energy distribution of the elastic peak over the primary energy range from 3.0 to 70.0 eV showed that shifting or broadening of the peak due to phonon excitation had to be less than 10 MeV over this entire energy range. (TAB)

6973 (AROD-3347:7) PARTICLE PHYSICS AND NUCLEAR DECAY. Final Report. Page, Lorne A.; Brimhall, James E. (Pittsburgh Univ., Pa.). [1965]. 57p. CFSTI $3.00 cy, $0.75 mn.

Experiments were performed using high-resolution lithium-drifted germanium detectors to determine the energy width of the annihilation of positronium. The application of an electric field in gaseous oxygen was used to enhance the formation of positronium, thus decreasing the fraction of positrons which annihilate with an electron bound to an atom. (S.F.L.)

6974 (BNL-9615) CRITICAL MAGNETIC SCATTERING FROM $KMnF_3$. Cooper, M. J.; Nathans, R. (Brookhaven National Lab., Upton, N. Y.). [1965]. Contract AT(30-2)-Gen-16. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Critical magnetic scattering experiments on the simple ionic antiferromagnet $KMnF_3$ are described. The observed intensity distributions are compared with those calculated from the Van Hove theory for quasi-elastic scattering using an experimentally determined resolution function. Excellent agreement is obtained with the Ornstein–Zernike form for the radial dependence of the correlation function in the temperature range $1.002 < T/T_c < 1.1$. The correlation range is found to increase from 12 Å at $T/T_c = 1.1$ to 200 Å at $T/T_c = 1.002$, and the inverse staggered susceptibility is found to follow very closely a 4/3 power law dependence on $T - T_c$. The results are also compared with recent results on ferromagnetic metals. (auth)

6975 (CALT-532-4) ELASTIC SCATTERING IN VELOCITY-SELECTED MOLECULAR BEAMS AT THERMAL ENERGIES. Cross, Jon B. (Illinois Univ., Urbana). Oct. 1966. Contract AT(11-1)-532. 180p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

A molecular beam apparatus is described which was designed to obtain total and differential scattering cross sections using a velocity-selected beam and a universal mass spectrometer detector. The product of the Lennard–Jones parameters ($\epsilon \cdot \sigma$) was determined from total scattering measurements for the following systems: N_2-N_2, 4.9×10^{-22} erg-cm ± 15%; D_2-Kr, 4.1×10^{-22} erg-cm ± 10%; H_2-Kr, 4.3×10^{-22} erg-cm ± 15%. (auth)

6976 (CEA-R-2952) ETUDE DES SECTIONS EFFICACES DE DOUBLE ECHANGE DE CHARGES (σ_{1-1}) D'IONS H^+, D^+, TRAVERSANT DIFFERENTS GAZ ORGANIQUES DANS UNE GAMME D'ENERGIE COMPRISE ENTRE 10 ET 50 keV. (Study of the Double Charge-Exchange Collision Cross Sections of H^+, D^+, Li^+ Ions With Organic Molecules in the Energy Range 10 to 50 keV). Farrokhi, Samad (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 79p. (In French). Dep. mn.

Thesis. Submitted to Univ., Paris.

The variation of the double charge-exchange collision cross sections of H^+, D^+, Li^+ ions with organic molecules (CH_4, C_2H_6, C_3H_8, C_4H_{10}) in the energy range 10 to 50 keV has been studied. Several maximums for $\sigma_{1-1} = f(E)$ have been shown. Their existence should be explained by the different possibilities of dissociating the target molecules. The position of the maximum for the $H^+ \rightarrow H^-$ and $D^+ \rightarrow D^-$ reactions is in good agreement with that defined by Massey's adiabatic relation. (auth)

6977 (N-66-30825) PROJECT CUBED: A CODE TO UNFOLD BREMSSTRAHLUNG EXPERIMENTAL DISTRIBUTIONS. Quarterly Report No. 1, January 13–April 13, 1966. Steyn, Julian J. (Nuclear Utility Services, Inc., Washington, D. C.). Contract NAS5-10133. 29p. (NASA-CR-76291). CFSTI $3.00 cy, $0.65 mn.

The initial development of a Fortran IV IBM 7094 digital computer code to unfold bremsstrahlung photon distributions recorded by a NaI scintillation spectrometer is discussed. The code (CUBED) is described in some detail. A system response matrix is generated from the characteristic spectra of standard radioisotope sources and applied to compute the incident photon number distribution by the Scofield iterative unfolding technique. The code executes ancillary analysis such as determination of energy differential spectra, energy integrated number, energy, and dose data. The code description is preceded by a short theoretical background discussion. CUBED makes use of certain existing codes; these are delineated. (auth)

6978 (NASA-TN-D-2773) X-RAY SPECTRA PRODUCED WHEN THICK SILICON TARGETS ARE BOMBARDED WITH 1.05 AND 1.25 MILLION VOLTS ELECTRONS. Singh, Jag J.; Adams, Richard; Gross, Chris (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Dec. 1966. 31p. CFSTI $3.00 cy, $0.65 mn.

Measurements have been made on the x rays produced when thick silicon targets are bombarded with 1.05- and 1.25-MeV electrons. (These energies are based on the range–energy relationship for electrons in aluminum.) The various cross sections, after correction for efficiency and finite resolution of the sodium iodide crystal for x rays, have been compared with the predictions of the Bethe–Heitler theory. The predicted pulse-height and angular distributions of the x rays are in qualitative agreement with the measured values. However, the absolute magnitudes of the measured x-ray intensities, at both energies of the electrons, are smaller than the theoretical values (relativistic, nonscreened, and no backscattering considered). (auth)

6979 (NYO-3708-2) A STUDY OF ALPHA PARTICLE REACTIONS IN ATMOSPHERIC GASES. Quarterly Progress Report No. 2, August 16–November 15, 1966. Report No. VC-2279-P-2. Fluegge, Robert A. (Cornell Aeronautical Lab., Inc., Buffalo, N. Y.). Nov. 30, 1966. Contract AT(30-1)-3708. 5p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Primary and subsequent events that occur as a result of gas bombardment by alpha particles will be investigated during the experimental portions of the program. The vacuum and electronics system modifications were completed and preliminary testing of each was undertaken. The alpha particle energy spectrum measured for the Am-241 source and associated 0.0002" stainless steel window is presented. The energy scale was estimated using the absorption characteristics of stainless steel; the calibration was not absolute. A block diagram of the experimental system that has evolved from the preliminary testing is presented. (W.D.M.)

6980 (ORNL-4027) RELATIVISTIC AND NON-RELATIVISTIC SCF WAVE FUNCTIONS FOR ATOMS AND IONS FROM Z = 2 TO 80, TOGETHER WITH CALCULATIONS OF BINDING ENERGIES, MEAN RADII, SCREENING CONSTANTS, CHARGE DISTRIBUTIONS, AND ELECTRON SHAKE-OFF PROBABILITIES.

Nestor, C. W.; Tucker, T. C.; Carlson, T. A.; Roberts, L. D.; Malik, F. B.; Froese, C. (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 92p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two groups of FORTRAN programs for the CDC 1604-A computer for calculating atomic wave functions, and some calculations performed with them are discussed. The first code gives a nonrelativistic Hartree–Fock solution, while the other group of codes yields a relativistic Hartree solution, to which an exchange correction may be added. Over 60 sets of wave functions for atoms and ions have been calculated. A number of solutions are for ions with vacancies in their inner shells. Energy eigenvalues, mean radii and screening constants are tabulated for each set. Plots of the electron distribution, which are also available for each wave function, are described. These wave functions have been used to calculate the probability of electron shake-off as the result of the following processes: β^- decay, electron capture, photoionization, and Auger transistions; and results of these calculations are given for nearly 40 cases. A brief discussion is given of a non-relativistic continuum wave function program and of the use of the Wigner–Seitz boundary condition in the relativistic Hartree calculation. (auth)

6981 (SC-RR-66-394) CALCULATION OF THE THERMODYNAMIC PROPERTIES OF A NITROGEN–OXYGEN–ARGON GAS MIXTURE. Shipley, K. L. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1966. Contract AT(29-1)-789. 125p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A summary of the statistical mechanical theory used in computing equilibrium thermodynamics properties of gas mixtures is presented. This theory is then applied to formulate a computational procedure for calculating the properties of a nitrogen–oxygen–argon gas mixture. The initial quantitative makeup of the three-element mixtures is arbitrary; the final composition at a specified temperature and pressure consists of up to 21 particle species. Debye–Hückel theory and second virial computations were added to provide real gas corrections. Quantum energy levels of constituents and sample calculations are given as appendixes. (auth)

6982 (TID–22398) THE STRUCTURE OF THE (1S) (2S) (2P) ^{4}P STATE IN ^{6}Li AND ^{7}Li. Manson, Steven Trent (Columbia Univ., New York. Dept. of Physics). [nd]. Contract AT(30-1)-3553. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A variational calculation is performed to obtain the energy and wave function for the (1S) (2S) (2P) ^{4}P state of lithium. The wave function, consisting of single electron orbitals, is then used to calculate the fine and hyperfine structure in ^{6}Li and ^{7}Li. The relevant matrix elements are done exactly by integrating by parts. (auth)

6983 (UCRL–12311(Rev.1)) ANALYSIS OF PROTON CHANNELING USING A STATIC POTENTIAL MODEL. Smith, H. P. Jr.; Khan, J. M.; Potter, D. L.; Worley, R. D. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 14, 1965. Contract W-7405-eng-48. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A model is proposed to describe the channeling of protons along low index directions and is applied to the interpretation of characteristic x-ray yield as a function of the incident beam angle measured with respect to the crystallographic vector. It is shown that the rotationally averaged interatomic force field can be calculated directly from the data. For proton bombardment of monocrystalline copper, it is found that the force on a proton in a ⟨110⟩ channel of copper can be taken as constant at approximately 800 eV/Å over a restricted but defined transverse area of the channel. Extension of the simplified version presented here to a more sophisticated calculation is discussed. (auth)

6984 (UCRL–14406) NEGATIVE MASS INSTABILITY. Landau, Ronald W.; Neil, V. Kelvin (California Univ., Livermore, Calif. Lawrence Radiation Lab.). Sept. 28, 1965. Contract W-7405-eng-48. 65p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A canonical formalism was developed for the description of the negative mass instability (N.M.I.). The formalism was applied to the formulation of a kinetic equation which is solved by the method of characteristics (or integration over orbits). It is found that a spread in betatron oscillation amplitudes contributes to stability, in addition to the spread in the canonical angular momentum. The N.M.I. equation for two streams is also obtained, and the result is the same as though each stream were present separately. It is also shown that the linear two-stream equation does not apply for a circular beam geometry; instead, the N.M.I. two-stream equation applies. (auth)

6985 ZERO-ENERGY ELASTIC SCATTERING LENGTH OF POSITRONS FROM HELIUM ATOMS. Hashino, Tasuke (Kurume Technical Coll., Kyushu, Japan). Progr. Theoret. Phys. (Kyoto), 36: 671-8(Oct. 1966).

The scattering length is calculated for elastic scattering of slow positrons (with vanishing velocity) by helium atoms according to the variational methods of Kohn and Hulthén. The value obtained is −0.5462 in atomic units and is a little larger than the value −0.5754 of Kestner, Jortner, Cohen, and Rice. It is found that the value of the scattering length depends especially on the choice of the value of the dipole polarizability. (auth)

6986 HULTHEN ORBITAL AND HULTHEN CORRELATION FACTOR FOR THE GROUND STATE OF HELIUMLIKE SYSTEMS. Parr, Robert G.; Weare, John H. (Johns Hopkins Univ., Baltimore). Progr. Theoret. Phys. (Kyoto), 36: 854-5(Oct. 1966).

It is pointed out that Hulthen or 0's orbitals, without mixing in other orbitals, are generally excellent approximations to Hartree-Fock 1s orbitals. This is illustrated for $(1s)^2$ configurations of helium-like systems. (L.B.S.)

6987 ELECTRON–POSITRON EXCHANGE ENERGY AND POSITRON EFFECTIVE MASS IN AN ELECTRON GAS. Hamada, Tetsuo; Nakamura, Yosiaki (Ibaraki Univ., Mito, Japan). Progr. Theoret. Phys. (Kyoto), 36: 851-2(Oct. 1966).

The question as to whether the nonrelativistic formulation of the positron self-energy problem is adequate is considered. It is shown that the contribution from the electron-positron exchange interaction to the positron effective mass in an electron gas is negligible and thus the conventional nonrelativistic formulation is substantially exact for the problem. (L.B.S.)

6988 POPULATION OF HYDROGEN LEVELS IN THE ARGON–HYDROGEN PLASMA JET. Goldfarb, V. M.; Ilina, E. V.; Kostygova, I. E.; Lukyanov, G. A.; Silantyev, V. A. Opt. Spectros. (USSR) (Engl. Transl.), 20: 602-3(June 1966).

Translated from Opt. Spektros., 20: 1085-6(June 1966).

The radiation of plasma flowing into a vacuum through the supersonic nozzle of a dc argon plasmatron was investigated. The pressure in the arc chamber was 400 mm Hg and in the vacuum chamber, 0.04 mm Hg. The hydrogen was present as a small admixture or was specially added to the argon. The Mach number varied from 2 to 25 over several centimeters of the length of the jet, the electron concentration from 3×10^{15} to 10^{12} cm^{-3}, the electron temperature from 5×10^3 to 2.5×10^{3}°K. Argon and hydrogen lines, the recombination continuum, and molecular nitrogen bands (the second positive system) were observed in the plasma spectra. The intensity of the lines of the Balmer series was measured in order to determine the relative population of the hydrogen levels. (M.H.R.)

6989 EFFECTIVE CROSS SECTIONS FOR THE EXCITATION OF ALKALI-METAL ATOMS BY SLOW ELECTRON COLLISIONS. III. RUBIDIUM. Zapesochnii, I. P.; Shimon, L. L. Opt. Spectros. (USSR) (Engl. Transl.), 20: 525-7(June 1966).

Translated from Opt. Spektros., 20: 944-9(June 1966).

The cross sections for the excitation of 31 lines of the principal and subordinate series of the rubidium atom as well as 15 ionic lines have been experimentally determined. The characteristic behaviors of the cross sections for the lines of the subordinate series as a function of the principal quantum number of the upper level have been established. The effect of successive transitions on some levels of the principal and sharp series has been evaluated. (auth)

6990 VELOCITY MEASUREMENTS OF POLARIZED PARTICLES. Pommier, Jacques; Schermann, Jean-Pierre (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. B, 263: 830-2(Oct. 3, 1966). (In French).

A method for measuring the velocity of polarized particles is described. The method consists in setting up an oscillating magnetic field that depolarizes the particles as the beam passes through it. This can be achieved if the frequency of the oscillating field is $\nu = v/d$, where v is the particle velocity and d is the space traversed by the particle in the magnetic field. Then the particle velocity for which a depolarization will be detected is given by the relation $v = d\gamma H_0/2\pi$ where H_0 is the static magnetic field. Some experiments to which this method can be applied are discussed. (G.O.Y.)

6991 VERSATILE MULTIPLE CATHODE SPUTTERING FIXTURE. Humphries, R. S. (Corning Glass Works, Raleigh, N. C.). Rev. Sci. Instrum., 37: 1734-5(Dec. 1966).

A cathode holder has been developed which permits simultaneous sputtering of up to twelve cathodes of identical or differing materials. The simple disk shape requirement for the cathodes facilitates use of materials such as silicon, which are not compatible with the usual operations necessary for support. (M.H.R.)

6992 INTERACTION POTENTIAL BETWEEN MERCURY AND HELIUM ATOMS. Szudy, J. (Nicholas Copernicus Univ., Torun, Poland). Acta Phys. Pol., 30: 721-9(Nov. 1966).

The potential curves for the interaction of a mercury atom in

the 6^1S_0 and 6^3P_1 states with a helium atom in the 1^1S_0 state were determined by means of the Lennard–Jones (12–6) potential. The potential curve for the interaction in the ground states was determined on the basis of experimental studies of the thermodynamical properties of the two gases. For the interaction between helium and a mercury atom in the 6^3P_1 state the attraction energies, corresponding to the quantum numbers $\Omega = 0$ and $\Omega = \pm 1$, were calculated in dipole–dipole approximation. The repulsion branches of the potential curves for both values of Ω were determined by means of spectroscopic analyses of the effect of helium on the mercury resonance line. The determined potential curves give a qualitatively correct description of the phenomena of pressure broadening and shift of the mercury resonance line by helium. (auth)

6993 RADIATIVE LIFETIMES OF ULTRAVIOLET MULTIPLETS IN Si, P, S, O, Ne II, AND Ar II. Savage, Blair D.; Lawrence, G. M. (Princeton Univ., N. J.). Astrophys. J., 146: 940-3(Dec. 1966).

Radiative lifetimes were measured by the phase-shift method for seventeen multiplets in Si I, Si II, P I, P II, S I, S II, and one each in O I, Ne II, and Ar II. The lifetimes range from 0.4 to 200 nsec. Most of the transitions exhibited cascading for which a correction was necessary. Measurement of phase shift versus frequency at a number of different frequencies makes possible the cascade correction. Excitation was by collision of 200-volt electrons with molecules containing the atom of interest. When possible the radiative lifetimes were converted into absolute multiplet transition probabilities. (auth)

6994 BURIAL OF 60 keV DEUTERIUM IONS IN STAINLESS STEEL AND TITANIUM. Freeman, N. J.; Latimer, I. D.; Daly, N. R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nature, 212: 1346-7(Dec. 17, 1966).

The trapping of deuterium ions in stainless steel and titanium was studied by firing energetic ions at thin foils mounted in an ultrahigh vacuum system. The isotope separator of the AWRE was used to produce an intense beam of deuterium ions at 60 keV. The beam entered the target chamber through a series of apertures to strike the metal target at normal incidence. The background pressures was $\sim 10^9$ torr and beams up to 50 μA having cross-sectional area of 3×10^{-2} cm^2 were obtained. Two different techniques which were used to measure the trapping coefficients are described. (W.D.M.)

6995 POSITRON ANNIHILATION IN SOME AQUEOUS SOLUTIONS. Bertolaccini, M.; Bisi, A.; Zappa, L. (Politecnico, Milan). Nuovo Cimento (10), 46B: 237-47(Dec. 11, 1966).

Measurements are reported of intensities and annihilation rates of free positrons and positronium in aqueous solutions of alkali halides and ammonium nitrate. It was found that these salts are effective in quenching positronium formation; this quenching depends only on the negative ion and not on the positive one. The decay rate of positronium increases slowly with the salt concentration; a discussion is given. No evidence was found of the formation of positron compounds and in particular of $e^+NO_3^-$ whose formation was suggested by previous authors. (auth)

6996 ELECTRON DRIFT AND DIFFUSION IN DEUTERIUM AT 293 DEG K. McIntosh, A. I. (Australian National Univ., Canberra). Austral. J. Phys., 19: 805-11(Dec. 1966).

The drift velocity and the ratio of diffusion coefficient to mobility were measured for electrons in deuterium at 293°K over the ranges $0.006 \leq E/p \leq 5.0$ and $0.006 \leq E/p \leq 2.0$, respectively. The results are compared with those of other workers. (auth)

6997 THE $SO_{4,1}$ GROUP AND THE HYDROGEN ATOM. Castilho Alcaras, J. A.; Leal Ferreira, P. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Nuovo Cimento (10), 46B: 273-6 (Dec. 11, 1966).

Recently, attention has been devoted to the group $SO_{4,1}$ as the group of noninvariance of the hydrogen atom. As is well known, a particular irreducible representation of $SO_{4,1}$ exists which describes the whole spectrum of the system. A new approach is presented in order to derive a realization of the $SO_{4,1}$ algebra on the basis of the commutation relations of five variables π_μ (and its derivatives) subject to two conditions. (M.O.W.)

6998 AGE APPROXIMATION TO X-RAY TRANSPORT. Hogan, William S. (Battelle Memorial Inst., Columbus, Ohio). J. Appl. Phys., 37: 4826-31(Dec. 1966).

The well-known age approximation of neutron transport theory was applied to the photon transport problem. By treating photoelectric absorption analogously to resonance absorption in the neutron problem and using a first collision source term, calculations done for air compare favorably with Monte Carlo calculations for photon energies up to 100 keV, and to values of density times distance of about 30 g/cm^2. (auth)

6999 CALCULATION OF THREE-BODY COLLISONAL RECOMBINATION COEFFICIENTS FOR CESIUM AND ARGON ATOMIC IONS WITH AN ASSESSMENT OF THE GRYZINSKI CROSS SECTIONS. Dugan, John V. Jr. (Lewis Research Center, Cleveland, Ohio). J. Appl. Phys., 37: 5011-12(Dec. 1966).

Theoretical results are presented for α-recombination coefficients for cesium and argon ions. They are compared with experimental values, and the expected accuracy of the Gryzinski cross sections is discussed. (M.O.W.)

7000 THORIUM DISPENSER CATHODE FOR AN ELECTRON GUN. Glascock, Homer H. Jr. (General Electric Research and Development Center, Schenectady, N. Y.). J. Appl. Phys., 37: 4995(Dec. 1966).

A thorium dispenser cathode described here has the following features; (1) a life of thousands of hours at temperatures where it produces an available emission current density of several A/cm^2; (2) design permits fabrication of a range of sizes from 0.025 cm to 0.625 cm o.d.; (3) composition can be precisely controlled; and (4) no activation procedure is required and repeated exposure to air can be tolerated. (M.O.W.)

7001 YIELD AND ANGULAR DISTRIBUTION OF CESIUM-SPUTTERED MOLYBDENUM. Green, J. B.; Olson, N. Thomas; Smith, Harold P. Jr. (Univ. of California, Berkeley). J. Appl. Phys., 37: 4699-4702(Dec. 1966).

A radioactive tracer technique was adapted to the measurement of the yield (atoms/ion) and angular distribution (atoms/ion/sr) of molybdenum sputtered by a cesium ion beam normal to the (100) crystallographic face. The energy of the ion was varied from 1 to 7.5 keV, and the target temperature was varied from 77° to 473°K. The yield increased with energy and decreased with target temperature. Preferred emission in the ⟨100⟩ direction was measured, but emission in the ⟨111⟩ direction could not be resolved. The importance of ion channeling and the effects of thermal annealing on ion-induced damage are emphasized. (auth)

7002 SPECTRAL EXTENSION OF POTASSIUM PHOTOCATHODE SENSITIVITY. Ward, Samuel A. (CBS Labs., Stamford, Conn.). J. Appl. Phys., 37: 4768-73(Dec. 1966).

Photoelectric measurements on potassium deposited in argon at pressures of 1 to 24 torr have shown photoemission which is spectrally extended into the red when compared to vacuum-deposited potassium. In addition, these cathodes have exhibited a larger magnitude of increase of output current with increase of anode voltage than that obtained with vacuum-deposited cathodes. A mechanism based upon the cathode structure formed by gas ambient deposition is presented to explain these effects. (auth)

7003 CLASS OF INTEGRAL INVARIANTS IN MECHANICS. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 625-32(1966).

The integral invariant of the form $\int \varphi dx dy dz$ associated with the motion of a particle was investigated. The expressions for φ, in terms of Hamilton–Jacobi characteristic function, were obtained for the motion of a particle in a potential field as well as that of a charged particle on a steady electromagnetic field. Finally the results were generalized to the case of a system of particles. (auth)

7004 EFFECT OF MAGNETIC FIELD ORIENTATION ON POSITRON ANNIHILATION IN POTASSIUM. Gustafson, D. R.; Barnes, G. T. (Wayne State Univ., Detroit). Phys. Rev. Lett., 18: 3-9(Jan. 2, 1967).

The angular correlation of positron annihilation radiation in potassium metal is found to be dependent on the magnetic field orientation. The experimental results are interpreted using the spin-density-wave model of the electronic structure of potassium metal. (auth)

7005 SOURCE OF WELL-DEFINED ANNIHILATION GAMMA RAYS. MacKenzie, I. K.; Bird, H.; Boulter, J. (Dalhousie Univ., Halifax, N. S.). Nucl. Instrum. Methods, 47: 176-8(Jan. 1967).

The possibility of obtaining a source of well-defined gamma rays from singlet annihilation in positron annihilation and positronium formation and decay is investigated. Angular correlation curves for positron annihilation were obtained for several molecular sieves in vacuo and in an oxygen atmosphere. Of the materials tested Cenco Zeolite showed the most enhancement in the positronium peak (~13% of all annihilations). (L.B.S.)

7006 THE EXCITATION OF THE GROUND CONFIGURATION OF Fe XIII BY ELECTRON IMPACTS. Bely, F.; Bely, O.; Lan, Vo Ky (Observatoire de Paris, Meudon, France). Ann. Astrophys., 29: 343-4(July-Aug. 1966).

By use of the Coulomb–Born approximation, cross sections for the excitation of the 5 levels in the ground configuration of Fe XIII were computed. Knowledge of the cross section for the excitation

of the ground configuration of Fe XIII is fundamental for interpreting the spectrum of this ion emitted in the solar corona. Because the spin-orbit interaction is strong in Fe XIII, the different terms of the ground configuration $3p^2$ are divided into 5 levels. On the basis of the first-order perturbation theory, the wave function of these levels are given, and the wave-function coefficients are computed from the observed spectrum. Through this method, the intermediate coupling holding in Fe XIII was taken into account. In the tabulated results the collisional strengths are given for 3 different incident energies as well as for the Russell-Saunders coupling and the intermediate coupling for the ion. The levels $^3P_0$, $^3P_1$, $^3P_2$, $^1D_2$ and $^1S_0$ are designated by 1, 2, 3, 4 and 5. The order of magnitude of the cross sections obtained showed that the previous estimations were overestimated. The transition $3 \rightarrow 4$ is very sensitive to the coupling, whereas the other ones are not. The fact that the transition $1 \rightarrow 5$ has a cross section which is null is due to the symmetry of the coefficients. (BBB)

7007 GAS DISCHARGE INJECTION OF ELECTRONS INTO A RESONATOR. Yushkov, Yu. G.; Kreindel, Yu. E. Zh. Tekh. Fiz., 36: 1215-16(July 1966). (In Russian).

A microwave resonator was used to extract electrons from a Penning discharge. The 16 mm diameter cathodes of the Penning tube, mounted 14 mm apart, served also as the pole pieces for the 400 Oe magnetic field. In the wall of the 8 mm long 16 mm diameter cylindrical anode there was a 6 mm diameter hole for extraction of electrons. A 2 cm long cylindrical resonator with a Q of 8000 and having two diametrically opposite 8×12 mm openings in the central portion of its wall was mounted with one of these openings located 3 mm from the hole in the Penning tube anode. The resonator was excited in the E_{010} mode by 2.5 microsec 300 kW 3 kMHz pulses at a repetition rate of 50 sec^{-1}, and electrons extracted from the Penning discharge by the action of the uhf field of the resonator and passing through the two openings in the resonator wall were caught in a Faraday cup. A pressure of 8×10^{-5} mm Hg was maintained in the apparatus and the Penning discharge was operated at potentials up to 1.5 kV. Electron currents up to 0.5 mA were extracted from the Penning discharge, and under some conditions the extracted current amounted to 60% of the total discharge current. It is concluded that a considerable fraction of the current in a Penning discharge can be extracted with the aid of intense uhf fields that penetrate into the Penning tube. (ATD)

7008 EXCITATION OF INERT GASES IN ELECTRON-ATOMIC COLLISIONS. II. NEON. Felstan, P. V.; Zapisochnii, I. P.; Povch, M. M. (Uzhgorod State Univ., USSR). Ukr. Fiz. Zh., 11: 1222-30(Nov. 1966). (In Ukrainian).

The results are presented of a detailed study of the excitation cross sections of 27 lines of the 30 available as upper levels with an electron configuration of $(1s^2 2s^2 2p^5)$ 3p (the 2p level in Paschen's notation), and of the intensive lines for which these ten 2p levels are finite. The measurements were taken over a spectral range of 3400 to 9700 Å in the electron energy region from excitation potentials up to 150 eV and on observing the optimal neon pressure conditions, density and energetic homogeneity of the electron beam. The excitation functions of all investigated lines are distinguished by a distinct maximum at electron energy values up to 80 eV. An interesting feature of the lines from the $2p_{10}$ level is the presence of a second very sharp maximum of excitation near the threshold. The maximum excitation cross section of the lines fluctuates within very wide limits. For the group of lines with a 2p level the terminal cross sections differ to a greater extent than two orders. (auth)

7009 TEMPERATURE DEPENDENCE OF THE DIFFUSION CROSS SECTION OF METASTABLE HELIUM ATOMS IN HELIUM. Pakhomov, P. L.; Fugol, I. Ya.; Shevchenko, Yu. F. Zh. Tekh. Fiz., 36: 1312-14(July 1966). (In Russian).

The diffusion cross section (defined as $v/3ND$, where v is the mean atomic velocity, N is the gas density, and D is the diffusion constant) of metastable (2^3S_1) helium atoms in helium gas at 77, 64, and 20°K was measured by a plasma technique that has been described earlier. Plasmas were produced by 40-MHz discharges in a quartz tube containing helium at pressures (reduced to room temperature) ranging from 0.1 to 1.0 mm Hg and their decay was followed for up to 1.5 millisec by recording the absorption of the 3889 Å $2^3S - 3^3P$ helium line. The diffusion constants, calculated from the exponential decay curves on the assumption that the plasmas decayed entirely by diffusion to the wall of the vessel, were inversely proportional to the pressure within the 15% experimental error. (ATD)

7010 ELECTRON ATTACHMENT TO PROTONS IN ALKALI METAL VAPORS WITH THE FORMATION OF HIGHLY EXCITED HYDROGEN ATOMS. Il'in, R. N.; Oparin, V. A.; Solov'ev, E. S.; Fedorenko, N. V. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 36: 1241-50(July 1966). (In Russian).

Cross sections of Li, Na, K, Cs, He, Ne, Ar, and H_2 were measured for the electron attachment reaction of 10- to 180-keV protons with particular attention to the cross sections for production of highly excited hydrogen atoms. The beam, initially of protons, successively traversed the 12-cm-long heated target chamber, a weak transverse electric field which removed the charged particles, a strong (up to 160 kV/cm) electric field which ionized the highly excited atoms, and a magnetic field which separated the ions from the remaining neutral atoms. The neutral atoms were recorded with a secondary emission detector which was calibrated against a calorimeter. The alkali metals were introduced directly into the target chamber, and the pressure of the vapor target was determined from the temperature of the chamber. Thin target data were obtained for all the target materials, and thick target (up to 0.4 cm torr) data were obtained for Na and Ne and, at some values of the incident proton energy, for K, Cs, and CO_2. The results are presented graphically and in tabular form; they are discussed at some length and are compared with theoretical calculations and with data of other investigators. It is concluded that at incident proton energies up to 30 keV the alkali metal vapors are efficient targets for producing both highly excited and moderately or unexcited hydrogen atoms, but that at higher proton energies the inert gas and H_2 targets are more effective for producing highly excited atoms. (ATD)

7011 CHARGE-EXCHANGE COLLISION CROSS SECTIONS OF APPROXIMATELY 1-MeV NEGATIVE HYDROGEN IONS IN SEVERAL GASES. Dimov, G. I.; Dudnikov, V. G. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Tekh. Fiz., 36: 1239-40 (July 1966). (In Russian).

Cross sections of H_2, He, N_2, CO_2, C_3H_8, CCl_2F_2, and SF_4 for the $H^- \rightarrow H^0$ and $H^- \rightarrow H^+$ reactions of 0.9, 1.1, and 1.3-MeV H^- ions were measured. The measurements were undertaken in connection with charge-exchange injection of protons into storage rings. The H^- beam from a Van de Graaff accelerator was magnetically analyzed, focused with a quadrupole lens, passed through a charge-exchange chamber of 21 cm equivalent length, and separated into H^-, H^0, and H^+ beams with a magnetic field. The H^- and H^+ beam intensities were measured with Faraday cups, and the H^0 beam intensity was measured with a calorimeter. The charge-exchange chamber was separated from the rest of the apparatus by ion ducts 0.5 cm in diameter and 5 cm long, and gas pressures up to 10^{-4} mm Hg in the charge-exchange chamber did not appreciably affect the vacuum in the remainder of the system. Measurements were made at target thicknesses from 2×10^{12} to 3.5×10^{14} molecule/cm^2, and the $H^0 \rightarrow H^+$ cross sections were derived from the target thickness giving maximum H^0 yield. The cross sections, maximum H yields, and optimal target thicknesses are tabulated. Accuracies of 18, 23, and 30% are claimed for the $H^- \rightarrow H^0$, $H^- \rightarrow H^+$, and $H^0 \rightarrow H^+$ cross sections, respectively. The $H^- \rightarrow H^+$ cross sections were from 3 to 6% of the corresponding $H^- \rightarrow H^0$ cross sections, and both were inversely proportional to the energy. The cross sections of the complex molecules were less than the sums of the cross sections of their constituent atoms. The maximum H^0 yield was approximately 50% for all the target gases. (ATD)

7012 K-SHELL IONIZATION OF Ag, Sn, AND Au FROM ELECTRON BOMBARDMENT. Rester, D. H.; Dance, W. E. (Ling-Temco-Vought, Inc., Dallas). Phys. Rev., 152: 1-3 (Dec. 2, 1966).

Cross sections for K-shell ionization have been measured at electron bombarding energies of 0.10, 0.15, 0.20, 0.25, 0.30, and 1.00 MeV for Ag, and of 0.20, 0.60, 0.80, 1.00, 1.20, 1.40, 1.70, and 2.00 MeV for Sn and Au. Below 0.50 MeV, the results for Ag are in excellent agreement with the relativistic calculations of Arthurs and Moiseiwitsch. For Sn at 0.20 and 0.60 MeV, where the theoretical values are available, the experimental cross sections are also in very close agreement. Although the experimental cross section for Au at 0.20 MeV is very nearly the same as the calculated result of Arthurs and Moiseiwitsch at this energy, at 0.60 MeV and higher electron energies the experimental results for Au are, on the average, about 15% lower than the values of Arthurs and Moiseiwitsch. (auth)

7013 K-SHELL PHOTOELECTRIC CROSS SECTIONS FOR THE FERMI-THOMAS POTENTIAL FROM 300 keV TO 1.3 MeV. Hall, Harvey (National Aeronautics and Space Administration, Washington, D. C.); Sullivan, Edward C. Phys. Rev., 152: 4-9 (Dec. 2, 1966).

The relativistic photoelectric cross section for the two electrons of the K shell has been computed using a numerical program. The four elements $Z = 26$, 50, 84, and 92 have been treated in the energy range of light quanta from 300 keV to 1.23 MeV. The results for the cross section are lower than for the unscreened Coulomb potential by an amount that ranges from approximately 7% at 354 keV for $Z = 26$ to 2.2% at 1.23 MeV for $Z = 92$. (auth)

7014 CLASSICAL HEAVY-PARTICLE TRAJECTORIES FOR ELECTRON CAPTURE IN H^+–He COLLISIONS AND FOR OTHER ASYMMETRIC COLLISIONS. Green, T. A. (Sandia Lab., Albuquerque, N. Mex.); Johnson, R. E. Phys. Rev., 152: 9-17(Dec. 2, 1966).

The method of perturbed stationary states, in a two-state approximation, is used to obtain semiclassical differential cross sections for electron capture or excitation in asymmetric ion–atom collisions at energies of the order of 1 keV. Two cases are discussed. In case A it is assumed that transitions between the two states occur only near a fixed internuclear separation; in case B it is assumed that they occur only near the distance of closest approach. Case B is studied in the limit of weak coupling; case A is studied both with and without this assumption. It is found that in each case the differential cross sections can be interpreted in terms of classical trajectories calculated from the potentials for the initial and final molecular states of the ion–atom system. It is also found that the impact-parameter calculation of the differential cross section may be considerably in error except at small impact parameters. The results for case A are shown to apply at least approximately to H^+–He collisions and are compared with the experimental data of Helbig and Everhart. (auth)

7015 IMPACT-PARAMETER CALCULATION OF ELECTRON CAPTURE IN CLOSE H^+–He COLLISIONS. Green, Thomas A. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 152: 18-20(Dec. 2, 1966).

The impact-parameter method is used to calculate the electron-capture probability for proton–helium collisions at kilovolt energies. A two-state, atomic eigenfunction expansion is used, and distortion, back coupling, and momentum transfer are taken into account. The results are compared with the experimental data of Helbig and Everhart. Good agreement is obtained for energies above about 10 keV; at lower energies the agreement is poor. The neglect of either distortion or momentum transfer is shown to destroy even qualitative agreement between theory and experiment. (auth)

7016 EXCITED STATES OF NEGATIVE IONS OF ATOMIC OXYGEN. Kivel, Bennett (Avco-Everett Research Lab., Everett, Mass.). Phys. Rev., 152: 21-5(Dec. 2, 1966).

The possibility of excited states in the negative atomic oxygen ion is reviewed. While the evidence is clear that a 3s orbital does not exist, this in itself does not rule out a 3p orbital in the ^4P configuration. Scaling from data on the photo-absorption of the ground state of O^- indicates that the $3p^4P$ state does not exist. (auth)

7017 CHARGE TRANSFER BETWEEN ALKALI-METAL IONS AND CESIUM ATOMS. Marino, Lawrence L. (General Dynamics/Convair, San Diego, Calif.). Phys. Rev., 152: 46-50 (Dec. 2, 1966).

The cross sections for charge transfer between alkali-metal ions and cesium atoms have been determined as a function of primary ion-beam energy from 50 to 4500 eV. In all cases, structure consisting of oscillations whose amplitudes increased with primary ion-beam energy was observed superimposed upon the normally expected form of the cross sections. Smith has shown that the cesium resonance results follow from the assumption that the difference between the even and odd eigenenergies ($V_g - V_u$) passes through an extremum. It is found that the resonant cross section can be described by $Q(cm^2) = Q_0(cm^2) - AV^{-\frac{1}{2}} \cos[\pi(|B|V^{-\frac{1}{2}} - \frac{1}{4})]$ where $A = 0.75 \times 10^{-16}$ cm^2 eV$^{\frac{1}{2}}$, $B = -820$ eV$^{\frac{1}{2}}$, V is the ion beam energy, and Q_0 is the nonoscillating portion of the cross section. This expression results from the assumption that $V_g - V_u$ passes through a minimum of a negative function of internuclear distance. Potential parameters consistent with the quoted values of A and B are given. The nonresonant results can be fitted by the form $Q = Q_0 - AV^{-\frac{1}{2}} \cos[\pi(|B|V^{-\frac{1}{2}} + \frac{1}{4})]$. (auth)

7018 MANY-BODY PERTURBATION-THEORY CALCULATION OF ATOMIC POLARIZABILITIES. Kelly, Hugh P. (Univ. of Virginia, Charlottesville). Phys. Rev., 152: 62-9(Dec. 2, 1966). (ORO-2915-53).

The use of many-body perturbation theory in problems involving multiple perturbations is discussed. The perturbation theory is applied to the calculation of the dipole polarizability of the ground state and of a number of low-lying excited states for atomic oxygen. For the ^3P ground state, the calculated polarizability is 0.783×10^{-24} cm. The effects of electron correlations are discussed. The monopole and dipole contributions to the polarization potential are presented for the $(2p)^3\ ^4S\ 3s\ ^5S$ state. (auth)

7019 RESONANCES IN THE SCATTERING OF ELECTRONS FROM ATOMS. Miller, William H. (Harvard Univ., Cambridge, Mass.). Contract NONR-1866(14). Phys. Rev., 152: 70-3 (Dec. 2, 1966).

A formal procedure is developed for describing the resonances in electron scattering from atoms caused by metastable, autoionizing states. It is shown that the position of a particular resonance is given exactly by the usual Rayleigh–Schrödinger perturbation series pertaining to an unperturbed discrete state embedded in an unperturbed continuum. An expression is given for the width, which shows explicitly what initial state i and final state f should be used in the "golden rule" as applied to autoionization: $\Gamma_{i\to f} = 2\pi|\langle f|V|f\rangle|^2$. The formal results are applied to the lowest ^1P_u resonance in $He^+ + e^-$ scattering; i.e., the $2s2p\ ^1P_u$ metastable state of He. The resonance energy obtained is 60.28 eV above the ground state of He, and the calculated width is 0.038 eV. These results are seen to be in excellent agreement with the experimental values. (auth)

7020 EXCITATION OF HYDROGEN MOLECULES BY ELECTRON IMPACT. II. EXCITATION TO $D(3p\pi\ ^1\Pi_u)$ STATE. Khare, S. P. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 152: 74-5(Dec. 2, 1966).

The investigation of the excitation of the hydrogen molecule by electron impact, employing one-center wave functions and Born and Born–Ochkur approximations, has been extended to the $D(3p\pi\ ^1\Pi_u)$ excited state. The oscillator strength is in excellent agreement with the experimental value of Geiger and with the theoretical value of Mulliken and Rieke. However, the values for the generalized oscillator strength are larger for $K < 0.33$ and smaller for higher values of K than those obtained by Roscoe. The total excitation cross sections are in fair accord with the estimates of Craggs and Massey. (auth)

7021 RESONANCES IN PROTON–HYDROGEN AND POSITRON–HYDROGEN SCATTERING. Mittleman, Marvin H. (Univ. of California, Berkeley). Phys. Rev., 152: 76-8(Dec. 2, 1966).

The problems of resonances in proton–hydrogen and positron–hydrogen scattering are studied. For proton–hydrogen scattering, resonances are predicted at energies just below each of the excitation thresholds. Infinite sequences of resonances are found just as in the electron-scattering case, but the widths are much narrower and these resonances are not presently observable. The positron–hydrogen scattering problem exhibits infinite sequences of resonances just below excitation thresholds, similar to the electron-scattering problem. Infinite sequences are also exhibited just below the thresholds for forming excited positronium. (auth)

7022 THEORY OF ELECTRON COLLISION EXPERIMENTS AT INTERMEDIATE AND HIGH GAS DENSITIES. Chantry, P. J.; Phelps, A. V.; Schulz, G. J. (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 152: 81-98(Dec. 2, 1966).

By means of a two-stream approximation, an analytical solution is obtained to the equation of transfer governing the steady-state concentration of monoenergetic electrons within a slab of gas bounded by two infinite planes, one of which emits a constant current density normal to its surface. The theory places no restriction on the gas pressure and includes the effects of inelastic collisions and partial reflection of scattered electrons at one or both boundaries. The results are applied to electron-beam experiments at intermediate and high pressures where the mean free path of electrons is comparable to or less than the length of the collision chamber. Analytical expressions are obtained for the electron current transmitted through the gas and for the normalized ion currents to be expected in the case of total ion collection and in the case of sampling through a slit. The effect of elastic and inelastic collisions may be represented by an "equivalent length factor" that modifies the equations normally applicable under low-pressure conditions. The results of the present theory are compared with previous theories, with particular reference to their use in interpreting experiments of the Maier–Leibnitz type, designed to measure absolute values of inelastic-collision cross sections. (auth)

7023 MOESSBAUER EFFECT IN TWO EXCITED STATES OF A ROTATIONAL BAND IN ^{171}Yb. Kalvius, G. M.; Tison, J. K. (Argonne National Lab., Ill.). Phys. Rev., 152: 829-32 (Dec. 9, 1966).

Mössbauer measurements on the ratio of the quadrupole splitting of the first and second excited states in ^{171}Yb show that the intrinsic quadrupole moment is constant within the experimental error of 3% for the first two members of the $K = \frac{1}{2}$ rotational band. The width of the resonance line gives a lifetime for the 75.9-keV state in ^{171}Yb of $\tau = (1.5 \pm 0.3)$ nsec. This is 40% shorter than the electronically measured value. The electric field gradient for the C_2 site in Yb_2O_3 is found to be $(2.83 \pm 0.06) \times 10^{18}$ V/cm^2. (auth)

7024 EFFECTS OF INSTABILITIES AND SCATTERING IN ELECTRON BEAMS IN THE ABSENCE OF A MAGNETIC FIELD. Kofoid, M. J.; Zieske, P. (Boeing Scientific Research Labs., Seattle). Phys. Fluids, 9: 2301-3(Nov. 1966).

Space-charge-focused 10-mm-diam low-voltage electron beams, in the absence of a magnetic field, suffer a rapid decrease of collected current with axial distance. A positive well harboring oscillations is formed, and beam electrons incur a velocity spread. (auth)

7025 HYPERFINE STRUCTURE AND PARAMAGNETIC PROPERTIES OF EXCITED STATES OF XENON STUDIED WITH A GAS LASER. Schlossberg, H. R.; Javan, A. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 17: 1242-4 (Dec. 19, 1966).

Measurements are reported of the g values of several excited states of Xe, together with estimates of their radiative lifetimes. (M.O.W.)

7026 THEORY OF "SUPERTAILS" OF IONS BOMBARDED INTO CRYSTALS. Sparks, M. (Hughes Research Labs., Malibu, Calif.). Phys. Rev. Lett., 17: 1247-50(Dec. 19, 1966).

A theory is described for measuring diffusion constants and binding energies of damage centers which are otherwise difficult to measure. The different types of ion concentration profiles such as $\exp(-x^2)$, $\exp(-kx)$, and $(x + d)^{-7}$ are discussed. (M.O.W.)

7027 USE OF OPERATOR EQUIVALENTS. Smith, D.; Thornley, J. H. M. (Oxford Univ.). Proc. Phys. Soc. (London), 89: 779-81(Dec. 1966).

Angular momentum operators transforming in the same way as spherical tensors are listed up to sixth order, and a general expression for their matrix elements is given. (auth)

7028 PROTON IMPACT EXCITATION OF THE n ^{1}D STATES OF He. McDowell, M. R. C.; Pluta, K. M. (Univ. of Durham, Eng.). Proc. Phys. Soc. (London), 89: 793-7(Dec. 1966).

The impact parameter version of Born's approximation is used to calculate cross sections for proton impact excitation of the n ^{1}D states of He (n = 3,4) from 1 ^{1}S and 2 ^{1}P. The results for 1 ^{1}S → 4 ^{1}D are in satisfactory accord with experiment. (auth)

7029 THEORY OF THE EXTENDED X-RAY ABSORPTION FINE STRUCTURE. Vishnoi, A. N.; Agarwal, B. K. (Allahabad Univ., India). Proc. Phys. Soc. (London), 89: 799-804(Dec. 1966).

A general formula was developed for the fluctuations in the x-ray absorption coefficients observed on the high-energy side of an absorption edge, on the assumption that the ejected photoelectron undergoes inelastic collisions in the vicinity of the absorbing atom only. For the intermediate-energy range 50 to 250 eV the directional dependence of the scattering event was taken into account by replacing the atoms at a given distance from the absorbing atom by a continuous distribution on a spherical shell of the same radius. The positions of the absorption maxima and minima were calculated for copper and compared with experiment. Reasonable agreement was found between the experimental results and the present calculations. (auth)

7030 PENETRATION OF ELECTRONS INTO MATTER. Tomlin, S. G. (Univ. of Adelaide). Proc. Phys. Soc. (London), 89: 805-19(Dec. 1966).

On the basis of Lewis's theory of multiple scattering in an infinite medium, relatively simple expressions are obtained for the first and second moments of the electron distribution in depth, and for the second moment of the transverse distribution, as functions of atomic number and incident electron energy. The results are compared with some Monte Carlo calculations due to Bishop. These moments are then used to determine semi-empirical expressions for the distribution functions. These results are compared with the Monte Carlo distributions for copper, in which instance good agreement is found. Some discussion is given of the applicability of these results, and possible modifications, to the case of the semi-infinite medium. (auth)

7031 CONCEPTUAL DEVELOPMENT OF QUANTUM MECHANICS. Jammer, Max. International Series in Pure and Applied Physics. New York, McGraw-Hill Book Co., 1966. 410p. $10.50.

Various chapters are presented on the formation of quantum conceptions, early applications of quantum conceptions to line spectra, the older quantum theory, the transition to quantum mechanics, the formation of quantum mechanics, statistical transformation theory, the Copenhagen interpretation, validation of the theory, and the fundamental problems. (M.O.W.)

7032 PURE QUADRUPOLE SPECTRA OF RARE NUCLEI IN SOLIDS. Slusher, Richart Elliott. Berkeley, Calif., Univ. of California, 1966. 228p.

Thesis.

A nuclear double resonance method has been demonstrated, which is capable of detecting pure nuclear electric quadrupole interactions of nuclei with low concentrations in solids. Rare nuclei with molar concentrations as low as 1 part in 10^7 have been detected in NaCl crystals. The nuclear dipole interaction of the rare nuclei with an abundant system of nuclei is the means for detecting the rare nuclear quadrupole interactions. The technique requires an abundant system of nuclei with an easily observable nuclear magnetic resonance and a long spin-lattice relaxation time in zero magnetic field. The sensitivity for detecting rare nuclei is directly proportional to the time during which rare and abundant nuclei interact in zero field, the magnitude of their dipolar interaction, the signal-to-noise ratio of the abundant nuclear magnetization, and the internal dipolar coupling of the abundant nuclei. This method is examined theoretically using density matrix techniques and a simple thermodynamic equilibrium model. A more complete second-order perturbation theory of the dynamics of the detection process is outlined. The effect of phase shifting and frequency modulation of the rf magnetic field applied at the rare nuclear quadrupole resonance is explained. The double resonance method is used to detect quadrupole interactions of Na and Cl nuclei near impurities and imperfections in NaCl crystals. A frequency modulation technique has been used to identify the Na and Cl quadrupole interactions near a K^+ substitutional ion. A model is suggested for observed quadrupole resonance associated with Br^- substitutional ions. An unsuccessful search has been made for deuterium (natural abundance, 0.0156%) quadrupole resonance in $CaSO_4 \cdot 2H_2O$ and $C_{10}H_8$. Requirements for long nuclear spin-lattice relaxation time in zero magnetic field are discussed. Suggestions are made for detecting quadrupole interactions of ^{17}O, ^{33}S, and other rare nuclei in proton or fluorine solids. (TSS)

7033 ELECTRON DETACHMENT IN COLLISIONS OF O^- IONS WITH RARE GAS ATOMS. Wynn, Marion John. Gainesville, Fla., Univ. of Florida, 1965. 90p.

Thesis.

Cross sections for electron detachment of O^- ions in the rare gases He, Ne, and Ar have been measured over the energy range 5 to 375 eV. The detachment cross sections for the $O^- - He$ system were measured using two different experimental techniques. Primary O^- ions were produced in a high-pressure source by electron bombardment of a jet of O_2 molecules. After mass analysis the primary O^- beam was directed into a collision chamber containing scattering gas at a pressure of about 10^{-3} torr. In the first experiment, a radio-frequency electron filter was used to separate the electrons from the heavy ions. This filter arrangement was used to measure the total electron detachment cross section for collisions of O^- ions with Ar, He, and Ne. The second experiment was based on the kinematic consideration that for incident ions having masses greater than those of the target particles, there exists a maximum laboratory scattering angle for the elastically scattered ions, and on the experimental fact that the kinetic energies of the electrons produced by the gas phase detachment process are very low compared with the energies of the primary ions, for ion energies greater than about 4 eV. A new collision chamber based on the above considerations was designed with an open collision volume, in front of which a retardation grid served to repel the low-energy electrons, and thus separate them from the more energetic elastically scattered and primary heavy ions. This retardation collision chamber was used in measurements of the detachment cross section for the $O^- - He$ system over the energy range 5 to 41 eV. A phase space argument is used to derive a threshold law for the detachment process. This law is fitted to the $O^- - He$ detachment data obtained from the retardation experiment, and predicts a value of 1.41 ± 0.4 eV for the electron affinity of O, which agrees with the accepted value of 1.465 eV. (Dissertation Abstr.)

7034 ABSOLUTE MEASUREMENTS OF TOTAL CROSS SECTIONS FOR THE SCATTERING OF LOW-ENERGY ELECTRONS BY ATOMIC OXYGEN. Sunshine, Gabriel. New York, New York Univ., 1965. 94p.

Thesis.

The atom beam recoil technique has been used to measure absolute total cross sections for the scattering of electrons by atomic oxygen in the energy range 0.5 to 11.8 eV. In this method, observations are made on an atom beam crossfired by a modulated electron beam. Recoil results in scattering out of the beam at the modulation frequency. A mechanical chopper is utilized so that both the total atom beam and its scattered component may be measured by the same ac detection and amplification system; therefore, it is possible to determine absolute cross sections without having knowledge of the beam detection efficiency or the overall gain of the amplification system. The source of atomic oxygen was a low-power rf discharge that, typically, dissociated 25% of a molecular oxygen beam. The beam detector consisted of an ionizing electron gun followed by a 60° mass spectrometer, and an electron multiplier. The full-beam signal (mechanically chopped) and the atom-scattering signal were detected by a narrow-band phase-sensitive lock-in ampli-

fier; the lock-in signal was fed to a voltage-to-frequency converter and then to a scaler-timer for integration. The cross sections measured are 30 to 50 per cent larger than those of Neynaber, et al. It should be noted that the angular resolution of the present experiment averages to about 15° compared with the resolution of 25° for the work of Neynaber, et al. (Dissertation Abstr.)

7035 POSITRON ANNIHILATION IN A DIATOMIC CRYSTAL: LITHIUM HYDRIDE. Eder, Leslie Edmond. New York, New York Univ., 1965. 78p.

Thesis.

Up until 1961 existing theories could account for all the essential features then known about positron annihilation and coherent x-ray scattering in diatomic crystals in a mutually consistent manner. The angular correlation data from positron annihilation in LiH appeared to be in disagreement with the x-ray scattering data. Basic elements neglected in the theory, which were unimportant in the cases studied up to that time but which make themselves significantly felt in the diatomic crystal of LiH, were sought. Self-consistent electron wave functions with exchange were calculated for the LiH crystal in the cell approximation. As the first test of the theory the coherent x-ray structure factors of LiH were calculated. The agreement between the structure factors for even and odd reflections and experiment leaves the burden of the discrepancy on the analysis of the annihilation data. Within the framework of the cellular method, the momentum density of annihilating electron–positron pairs is expressed as the square of the sum of two terms each originating from one of the two atoms in the unit cell. For diatomic crystals, such as LiH, which are only weakly ionic, both terms are important. On squaring, therefore, three terms are obtained, one from each of the two atoms in the unit cell and a third one, an interference term, which accounts for the phase relations between the wave functions within the unit cell. It is confirmed for the LiH crystal that if all three terms are retained the apparent discrepancy is completely resolved. (Dissertation Abstr.)

7036 RELATIVE POPULATION DENSITIES AND TRANSITION PROBABILITIES IN A NEON GLOW DISCHARGE. Irwin, John Caarles Nathaniel. Vancouver, B. C., Univ. of British Columbia, 1965.

Thesis.

An experimental technique has been developed for the investigation of departures from thermodynamic equilibrium in plasmas. The relative populations of the upper and lower levels of a spectral line are measured by the reversal temperature method. The reversal temperatures themselves are determined by varying the relative exposure times of the background source and the plasma to be investigated. The relative population densities of the levels in the $2p^53s$ and $2p^53p$ configurations of NeI have been measured. A neon glow discharge operated in the current region 1mA to 100mA served as the plasma. The results show that the excited gas is definitely not in thermal equilibrium. The relative intensities of the emission lines between the $2p^53s$ and $2p^53p$ configurations of NeI were measured photometrically and corrected for self-absorption. These intensities were then used in conjunction with the relative population densities to determine relative transition probabilities for the spectral lines concerned. The results are accurate to approximately 10% to 15% and are compared to the values obtained previously by other workers. (Dissertation Abstr.)

Cosmic Radiation

Refer also to abstracts 6058, 6069, 6906, 6921, 7084, and 7122.

7037 OMNIDIRECTIONAL INVERSE COMPTON AND SYNCHROTRON RADIATION FROM COSMIC DISTRIBUTIONS OF FAST ELECTRONS AND THERMAL PHOTONS. Felten, James E. (Univ. of California, San Diego, La Jolla); Morrison, Philip. Astrophys. J., 146: 686-708(Dec. 1966).

An attempt is made to interpret the observed diffuse component of cosmic x rays and gamma rays as inverse Compton radiation from relativistic electrons in tenuous regions of space. The inverse Compton effect (production of a high-energy photon by the collision of a fast electron with a low-energy photon) is discussed kinematically in the Thomson approximation, and useful formulas are obtained. For the special case of thermal photon and power-law electron distributions, explicit brightness formulas for astrophysical use are derived; a δ-function approximation for scattering by a single electron is employed. Similar brightness formulas are derived for synchrotron emission; the limitations of the derivation are examined and the formal analogy between the two processes is emphasized. A qualitative comparison is made between expected synchrotron and Compton spectra of the galactic halo. The electron spectrum of the halo is discussed in some detail, and its probable form is derived on the basis of equilibrium against energy losses in a uniform diffusive trapping region. The diffusive escape time is assumed to be $\sim 10^8$ years. Inverse Compton losses are taken into account; starlight energy density in the halo is estimated to be $\sim 10^{-1}$ eV cm^{-3}. The resulting galactic electron spectrum is normalized to radio observations, and the expected inverse Compton flux due to interaction of starlight with the same electron spectrum is calculated. The process is repeated with the additional assumption that cosmic black-body radiation at 3°K is present. These two curves are compared with collected x- and gamma-ray data; the higher of the two (the 3°K curve) lies 2 orders of magnitude too low. It is concluded that halo electrons are insufficient to produce the observed radiation. The shape of the spectrum they produce is, however, compatible with that observed. Emission by halos of external galaxies is discussed briefly but is likewise insufficient. Other metagalactic models are considered, in which electrons are present not only in galaxies but also in tenuous regions of low field and possibly spread throughout space. Equilibrium spectra for such electrons are derived and then normalized to the observed x-ray spectrum. If the 3°K radiation is present, the required electron spectrum has differential exponent ≈ -3.4 and lies about a factor of 10^3 below the halo spectrum in the region 1 to 10 GeV. Possible sources of injection for such a metagalactic flux are discussed; secondary production by a universal cosmic-ray flux and escape of electrons from strong radio galaxies are viable source mechanisms. Regardless of source theories, the metagalactic electron flux at 0.5 to 10 GeV has some empirical footing in the x-ray observations. (auth)

7038 GALACTIC X RADIATION. Bleeker, J. A. M. (Werkgroep Kosmische Straling, Delft, Netherlands). Ned. Tijdschr. Natuur., 32: 171-83(May-June 1966). (In Dutch).

The techniques used for the detection of galactic x radiation and the observations that have been made up to the present are briefly reviewed. Some physical processes that can lead to the production of galactic x radiation are described. (J.S.R.)

7039 STUDY OF LOW-ENERGY HEAVY COSMIC-RAY NUCLEI BY SLICING EMULSIONS. Fukui, K. (Air Force Cambridge Research Labs., Bedford, Mass.). Nuovo Cimento (10), 46A: 529-38(Dec. 1, 1966).

In order to study low-energy heavy nuclei in nuclear emulsion recovered from a polar orbiting satellite, a new technique of slicing emulsion was applied. Three small sheets of emulsion exposed parallel to the satellite wall of 1.5 g/cm^2 were studied for steep tracks with dip angle greater than 38°. The emulsions were sliced normal to the surface into thin pieces which contained the tracks. Each slice was mounted on a glass plate so that the track lay flat. Charge identification of each track was determined by track area measurement. Differential fluxes were obtained for the M nuclei $6 \leq Z \leq 9$ in the 75 to 105 MeV/nucleon interval, and for H nuclei $Z \geq 10$ in the 105 to 180 MeV/nucleon interval. Combining these data with those previously published for a higher-energy region which were taken from the emulsion block flown on the same vehicle, the differential energy spectra were extended to cover the region where the maximum of each component occurs. The peaks of the energy spectrum are seen at about 180 to 200 MeV/nucleon for each component. (auth)

7040 MISSION DOSE PROBABILITIES DUE TO SOLAR-PROTON EVENTS. Haffner, J. W. (North American Aviation, Inc., Downey, Calif.). Trans. Amer. Nucl. Soc., 9: 334-5(Oct.-Nov. 1966).

7041 COSMIC RAYS. McCusker, C. B. A. (Univ. of Sydney). Sci. J., 2: No. 12, 64-9(Dec. 1966).

A brief review of cosmic-ray physics is given and the Sidney University Giant Airshower Recorder (SUGAR) is described. SUGAR consists of 100 stations on 1.6-km centers which will cover 250 km^2. At each station two liquid scintillation detectors record the shower of particles. There are, in addition, three large Cornell-type detectors in a triangular pattern around the array. (W.D.M.)

7042 SIDEREAL VARIATIONS OF HIGH-ENERGY COSMIC RAYS. Jatczak, J. (Univ., Lodz, Poland). Artif. Satellites, 2: 115-26(Mar. 1966).

Measurements were made of the sidereal–diurnal variations of high-energy cosmic radiation by recording extensive air showers initiated by particles arriving in a narrow vertical cone. It is shown that the anisotropy coefficient of cosmic radiation depends on the value of the diffusion coefficient and the mean intensity of the cosmic radiation and on the form of the radial distribution of the particle density of the primary radiation in the Galaxy. Adopting the concept of galactic origin of cosmic radiation, two models of the distribution of cosmic-ray sources are constructed. The re-

sults of measurements of extensive air showers with the aid of an apparatus in which penetrating components and charged particles are recorded separately are subjected to Fourier analysis. (Int. Aero. Abstr.)

7043 MEASUREMENT OF THE SPECTRA OF LOW-ENERGY PRIMARY COSMIC-RAY HYDROGEN AND HELIUM NUCLEI AT SOLAR MINIMUM. Hofmann, David John. Minneapolis, Univ. of Minnesota, 1966. 184p.

Thesis.

A triple scintillation counter device was designed and constructed for the purpose of high altitude balloon studies of low-energy cosmic rays during a period of minimum solar activity. The instrument was capable of separating the isotopes of hydrogen (protons, deuterons, and tritons) and of helium (helium nuclei of mass 3 and 4) and of measuring the intensity and energy of these cosmic ray particles. A balloon flight of 30 hour duration of 12 May, 1965 from Barrow, Alaska, constitutes the principal experimental results of the thesis. Among these results are the following: (1) The differential energy spectrum of primary protons in the energy range 70 to 150 MeV is presented. (2) The differential energy spectrums of primary helium nuclei of mass 3 and 4 (taken separately) in the energy range 80 to 150 MeV/nucleon are presented. (3) The differential energy spectrum of secondary deuterons in the energy range 10 to 130 MeV is presented. (4) The differential energy spectrum of re-entrant albedo protons in the energy range 10 to 130 MeV is presented. The intensity of primary protons and helium nuclei measured in this experiment at solar minimum are compared with data taken at other times in the solar cycle by other experimenters and it is found that the observed solar modulation of particle intensities can be accounted for by a diffusion–convection model if the scattering mean free path has a rigidity dependence of the form $(1 + P/P_0)$ where P is the particle rigidity and P_0 is a parameter related to the magnetic field strength and scale size of the scattering irregularities in the interplanetary medium. About one out of every five helium nuclei measured (at the same energy/nucleon) was found to be the helium isotope of mass 3. The significance of these isotopes in the cosmic radiation is discussed and a comparison is made with other measurements. The conclusion is reached that the data obtained to date is not sufficiently statistically significant to make any definite statements about the interaction parameters and the interstellar medium involved in the production of these helium isotopes. The re-entrant albedo proton intensity at Minneapolis is found to make a significant contribution (about 50%) to the total intensity of secondary protons at balloon altitudes. (Dissertation Abstr.)

Direct Energy Conversion

Refer also to abstracts 6867, 6882, 7211, and 7240.

7044 (BMwF-FBK-66-28(Pt.1)) HERSTELLUNG UND UNTERSUCHUNG VON KARBIDISCHEN HEIZERN FUER EINEN MIT KERNENERGIE BETRIEBENEN THERMIONISCHEN KONVERTER. TEIL I. (Production and Investigation of Carbide Heaters for a Thermionic Converter Operating with Nuclear Energy. Part I). Janes, S.; Kadner, M.; Kling, H.-G.; Merz, D.; Oberender, W.; Schuster, K. (Battelle Institut e. V., Frankfurt am Main (West Germany)). Sept. 1966. 52p. (In German). Dep. mn.

The preparation of different specimens, constructed analogous to nuclear heaters for thermionic converters to be prepared later on, is described. Hot pressing of ZrC-pelletized coated particles with UC_x–cermet gives useful specimens. Addition of Mo or Mo + C proved impractical. (auth)

7045 (CEA-R-2974) CONTRIBUTION A L'ETUDE SUR UN NOUVEL EFFET DE CONVERSION D'ENERGIE IONISANTE EN ELECTRICITE. (Contribution to the Study of a New Ionizing-Energy Conversion Effect in Electricity). Ahrabi, Mohammad Rahim (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 63p. (In French). Dep. mn.

Thesis. Submitted to Univ., Paris.

When two identical electrodes at different temperatures are placed in a vapor or in a condensible ionized gas, an electromotive force is produced between the two electrodes. The potential differences obtained are too great to be attributed merely to a thermocouple effect, and the electromotive forces observed are of a quite different order of magnitude from those obtained theoretically using conventional hypotheses. (auth)

7046 (N-66-27187) PLASMA THERMIONIC DIODES. (Stanford Univ., Calif.). Dec. 1964. 18p. (NASA-CR-60145). CFSTI $3.00 cy, $0.65 mn.

Results for a low-pressure (collisionless) one-dimensional thermionic converter are summarized in a study of the randomization of electron energies in thermionic diodes by computer methods. It was found that when the separation between the emitter and collector plates is larger than ten electron Debye lengths, the operation of the diode is determined essentially by two parameters: (1) the ratio of charge densities near the emitter and (2) the applied potential. Plots of potential are included for four regions in which the fluctuations are expected to be the greatest. (STAR)

7047 (TID-23459, pp 79-93) ENERGY CONVERSION RESEARCH. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

A systematic attempt was made to design a segmented-electrode generator which will not exhibit the electrode shorting phenomena described earlier and still be capable of elevation of the electron temperature above the gas stagnation temperature. A description of the facility and its performance is presented. (M.O.W.)

7048 (UCRL-16662) WORK FUNCTIONS OF MONOCRYSTALLINE AND POLYCRYSTALLINE RHENIUM. Wichner, Ronald (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1966. Contract W-7405-eng-48. 108p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The bare work functions of polycrystalline rhenium and of the $(10\bar{1}0)$, $(10\bar{1}1)$, and (0001) orientations have been determined for planar emitters, in vacuum, at pressures of 2×10^{-10} to 7×10^{-9} torr and in the temperature range, 1415 to 2021°C. Electron emission currents were obtained in a thermionic diode as a function of applied voltage, at a number of temperatures. The work functions were determined by means of the Richardson plot and also deduced from the position of the knee in the current–voltage characteristic. The work function, ϕ, and Richardson "A" value, A_r, were found to be as follows: ϕ(poly) = 4.93 ± .02 eV, A_r(poly) = 74 ± 21 $A/cm^2{\cdot}K^2$; $\phi(10\bar{1}1)$ = 5.15 ± .02 eV, $A_r(10\bar{1}0)$ = 76 ± 21 $A/cm^2{\cdot}K^2$; $\phi(10\bar{1}1)$ = 5.37 ± .03 eV, $A_r(10\bar{1}1)$ = 119 ± 40 $A/cm^2{\cdot}K^2$; ϕ(0001) = 5.59 ± .05 eV, A_r(0001) = 199 ± 49 $A/cm^2{\cdot}K^2$. A guarded, single-crystal copper collector was employed in a plane geometry configuration in order to minimize edge and other nonuniform effects. A method was also developed for brazing the emitter buttons to tantalum support cups, using niobium as the high-temperature braze material. (auth)

7049 TRANSPORT THEORY FOR LOW-ENERGY PLASMAS WITH APPLICATIONS TO THERMIONIC CONVERTERS. Wilkins, Daniel R.; Gyftopoulos, Elias P. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 9: 337(Oct.-Nov. 1966).

7050 EFFECTS OF BOUNDARY CONDITIONS ON TRANSMISSION OF CURRENT THROUGH A THERMAL CESIUM PLASMA. Grodko, V. A.; Markar'yan, B. N. Zh. Tekh. Fiz., 36: 1163-5(July 1966). (In Russian).

A qualitative analysis based on experimental data was made of the dependence of physical processes occurring in the neighborhood of the electrodes in the plasma of a cesium diode, operating at "quasi-vacuum" and diffusion modes, on the work function of cathode material in vacuum ($\epsilon\varphi$). Each experimental diode was cylindrical and the distance between electrodes (d) was 1 mm. The directly heated cathode was 1 mm in diameter and 50 mm long. The collector consisted of three sections: the central or operating section (15 mm long), and two screening sections. The dependences of the short-circuit cathode current i on the pressure of cesium vapor p at fixed cathode and anode temperatures T_c and T_a, respectively, as well as on d for different values of φ (5.0, 4.5, 4.0, 2.7 V) i.e., for different boundary conditions on the cathode, were experimentally determined. The dependences show that in the investigated ranges of electrode temperatures and vapor pressures of cesium, the following relationships take place: at fixed T_c, T_a, d, and φ, the function i = i(p) passes through a maximum; the value of short-circuit current i_0 at optimum value of cesium vapor pressure p_0 and fixed electrode temperatures is independent of $|\varphi|$; a decrease of φ from 5.0 to 2.7 under the same conditions is followed by a continuous rise of p_0; an increase of T_c at fixed φ is followed by the rise of i_0 and p_0. The dependence of the effective cathode work function $\epsilon\psi$ on p at T_c = const and different values of φ shows that with the rise of p the greatest decrease of ψ corresponds to large values of φ. Investigation of the effect of T_c on the relationship between the optimum short-circuit current and the vapor pressure of cesium at fixed values of φ shows that a correspondence exists between large values of T_c and ψ. An increase of T_c may result in an increase in the value of optimum short-circuit current. Such variation of i_0 and p_0 caused by variation of T_c is consistent with the experiment. (ATD)

7051 ENERGETICS 7: THE COMPREHENSIVE VIEW. Henderson, R. E. (General Motors Corp., Indianapolis). Mech. Eng., 88: No. 12, 34-40(Dec. 1966).

The theoretical basis of direct energy conversion is discussed,

and design information is given on various systems with emphasis on the contact potential. Information is included on the following types of direct-conversion systems: thermoelectric, thermionic, photovoltaic, and electrochemical. Three types of direct-conversion applications which have considerable promise are discussed; solar thermionic converter, radioisotope thermophotovoltaic converter, and electrochemical engine. (J.H.M.)

7052 MAGNETOHYDRODYNAMIC GENERATING SYSTEM. Yano, Sykuro; Hiramoto, Tatsumi (to Nihon Genshiryoku Kenkyu Sho). U. S. Patent 3,283,183. Nov. 1, 1966. Priority date Oct. 30, 1961, Japan.

A system is provided in which an electrical field is used under a specified condition in an MHD generator and the conductivity of a gas generated by thermal ionization is increased by means of the electrical field and, therefore also the efficiency of the generator is increased over that of the present turbo-generator. The system consists of a reactor, electric field source, MHD generator, turbo-generator, and compressor. (W.D.M.)

7053 MAGNETO-HYDRODYNAMIC GENERATOR. Fonda-Bonardi, Giusto (to Litton Systems, Inc.). U. S. Patent 3,286,108. Nov. 15, 1966. Filed Dec. 21, 1961.

The invention relates to a highly efficient magnetohydrodynamic generator for converting the kinetic energy of ionized gas particles to an electromotive potential by reciprocating the gas particles back and forth across a magnetic field. (W.D.M.)

Fluid Physics

Refer also to abstracts 5848, 6908, and 6967.

7054 (AD-634098) ELECTRICAL CHARACTERISTICS OF THE LINEAR HALL AND FARADAY GENERATORS AT SMALL HALL PARAMETERS. Technical Information Series. Zauderer, B. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). June 1966. 38p. (R-66SD33). CFSTI $3.00 cy, $0.65 mn.

Experiments were performed to determine the electrical characteristics of the linear, segmented-electrode, Hall and Faraday MHD generators. The generator working fluid was shock-heated xenon at 7000°K gas temperature, one atmosphere pressure, equilibrium conductivity of 850 mhos/m, and a Hall parameter which ranged in value from 0.7 to 2.5. The study was performed with and without magnetically induced ionization effects in the generator. If the electrode voltage losses were included in the data analyses, the Faraday generator load characteristics were in agreement with the theory of Hurwitz, Kilb, and Sutton. If the voltage losses at the Hall current electrodes were included in the data analyses, the Hall generator load characteristics obtained under equilibrium plasma conditions were in agreement with the theory of Dzung. In the presence of magnetically induced ionization, the open-circuit Hall voltage and the Hall load characteristics were on the average 30 and 10% respectively below the theoretically predicted values. The Hall output reduction is attributed to plasma nonuniformities caused by gas dynamic forces, Lorentz forces and nonuniform extra-thermal ionization effects. However, it was not possible to determine from the present experiments which of these three loss mechanisms was dominant. (auth)

7055 (AD-637879) STABILITY OF UNIFORM ELECTRICAL CURRENT FIELDS IN CONDUCTING-RADIATING GASES. Cramer, Kenneth R. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). June 1966. 24p. (ARL-66-0106). CFSTI $3.00 cy, $0.65 mn.

The stability of a uniform two-dimensional electrical current field was analyzed with the result that continuum gases are unstable for non zero temperature disturbances when the electrical conductivity of the gas increases with temperature. Filaments of small arcs are predicted to occur between electrodes with different potentials. Filament halfwidths were estimated to be very small and not strongly dependent on the peak heat flux potential and they respond to voltage changes in less than a microsecond. The formation of numerous shorting filaments between adjacent electrodes in MHD Hall and segmented electrode devices is suggested as the cause of Hall potential losses. (auth)

7056 (AD-638522) MAGNETOGASDYNAMIC FLOW PATTERNS. Cap, Ferdinand; Fredel, Helmut (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). Aug. 2, 1965. Contract AF 61(052)-675. 8p. (AFOSR-66-1387). CFSTI $3.00 cy, $0.65 mn.

Resulting from the conditions about the validity of the potential equation of the ideal magnetogasdynamics, two distinct geometrics of potential flow are discussed. The two-dimensional steady potential equation is developed as a method in analogy of the Prandtl-Busemann method of gasdynamics and will be used for the calculation of the flow fields in a diverging nozzle. (auth)

7057 (AE-258) HALL EFFECT INFLUENCE ON A HIGHLY CONDUCTING FLUID. Witalis, E. A. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Nov. 1966. 13p. Dep. mn.

The properties of an incompressible perfect fluid exhibiting Hall effect is investigated in the limit of infinite electrical conductivity and mobility. The magnetic field strength and the fluid velocity are found to obey the equations $\underline{B} = (\mu\rho/\sigma)$ curl $\underline{V}$ and $\underline{V} = -(\mu/\sigma\mu_0)$ curl $\underline{B}$ (MKS units) where ρ, σ and μ denote mass density, conductivity and charge carrier mobility. Some physical interpretations and applications are given. (auth)

7058 (MMPP-293-1) FACILITY FOR THE INVESTIGATION OF A GAS-DRIVEN LIQUID VORTEX. Robinson, R. A.; Lafferty, J. F.; Hammitt, F. G. (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering). Oct. 1966. 40p.

Prompted by the potential applications of two-phase vortex flow to magnetohydrodynamics and nuclear reactors, an experimental facility has been constructed for the study of an air-driven water vortex. An air-balance system of pressure measurement is utilized and representative data are presented to indicate the accuracy and reproducibility of the measurements. A conductivity probe, developed especially for this project, is used to obtain local density measurements. Electrical coils, fabricated to provide a uniform radial magnetic field, are used to obtain the MHD characteristics of the vortex system. The preliminary work with this system has shown that a gas-driven liquid vortex can be maintained in a stable geometry with a mass flow ratio of about 10 lb-air/lb-water (volume ratio of about 10^4). The vortex was maintained for substantial periods with mass flow ratios as high as 45. (auth)

7059 (NASA-CR-646) ANALYSIS OF CONFINED MAGNETOHYDRODYNAMIC VORTEX FLOWS. Loper, David E. (Case Inst. of Tech., Cleveland, Ohio). Nov. 1966. Contract NsG-198/36-003-003. 150p. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The vortex flow of a viscous, incompressible and electrically conducting fluid confined between two finite flat plates (with a net radial mass flow) in the presence of an applied axial magnetic field is considered. The details of the velocity field including boundary layer blockage and redistribution of radial mass flow are of primary concern. The analysis is limited to the case of the separation distance between the two end plates being small compared with the radius of the plates; this allows the momentum equations to be uncoupled from the electromagnetic equations. The momentum equations are linearized and solved for the velocities and the pressure as Fourier series. The temperature and electromagnetic variables are then found. The velocity and temperature results are plotted and discussed, showing the influence of the magnetic effects upon the flow pattern. (auth)

7060 PARALLEL FLOWS OF MULTICOMPONENT VISCOUS PLASMA. Shioda, Susumu (Tokyo Shibaura Electric Co., Ltd., Kawasaki). J. Phys. Soc. Jap., 21: 2351-7(Nov. 1966).

Flows of two- or three-component viscous plasma between parallel flat plates and in a circular tube in the presence of a pressure gradient and an electric field parallel to the flow are investigated theoretically. Electrical neutrality, frozen ionization, uniform temperature, and uniform number densities are assumed since the work is concerned with the cases for which Mach number is small. The velocity profiles are decomposed into three modes: linear, parabolic, and exponential. The last one yields boundary layers whose thicknesses are of the order of the mean free path. It is shown that the electric current is induced not only by the electric field but also by the pressure gradient. (auth)

7061 ANNULAR EFFECT IN MHD: AN EXAMPLE OF A BOUNDARY VALUE PROBLEM TO BE SOLVED BY LIE SERIES FORMALISM. Schett, A.; St. Schirmaier, A.; Weil, J. W. (Univ., Innsbruck). Z. Phys., 198: 18-28(1967).

The extension of the hydrodynamic annular effect discovered by Richardson and calculated by Sexl to the magnetohydrodynamic case as given by Schirmaier is reproduced by applying the well-known method of Lie series to the solution of the Bessel equation which describes the behavior of the laminarly oscillating MHD fluid. (auth)

7062 UNSTEADY MOTION OF A VISCOUS HYDROMAGNETIC FLUID CONTAINED IN A CYLINDRICAL VESSEL. Groves, R. N. Jr. (Military Academy, West Point, N. Y.). J. Appl. Mech., 33: 748-52(Dec. 1966).

The problem of unsteady motion of an electrically conducting viscous liquid contained in a cylindrical vessel in the presence of an axially symmetric magnetic field of constant strength is

solved exactly by using concurrently two methods of operational calculus—the infinte Hankel transform and the Laplace transform. Results of these operations for general boundary conditions are presented in convolution integral form. The exact solutions of two special cases are presented in terms of tabulated functions, including those especially developed for the purposes of this paper. By examining the limiting cases of these special results, verification of results that have previously appeared in the literature and other interesting phenomena arise. (auth)

7063 TRANSMISSION ELECTRON MICROSCOPY OF VANADIUM–SILICON (V_3Si) AT LOW TEMPERATURES. Goringe, M. J. (Cambridge Univ., Eng.); Valdre, U. Proc. Roy. Soc. (London), Ser. A, 295: 192-216(Nov. 29, 1966).

It is shown that using a double tilting specimen holder cooled by liquid helium it is now possible to undertake the same kinds of study by transmission electron microscopy at very low temperatures as can be carried out at room temperature. The technique was applied to a detailed study of the microstructure formed during the martensitic phase transformation in thin foils of the intermetallic compound vanadium–silicon V_3Si (superconducting transition temperature 17°K) in the temperature range 11 to 29°K. The material was found to transform into twin related lamellae, sometimes only 100 Å thick, the twin planes being {110}. The preferred {110} twin plane varies from region to region in the specimen, and in some areas lamellae parallel to different {110} planes interpenetrate. Ciné techniques were used to record the changes in structure taking place during the transformation. The contrast effects observed are interpreted. (auth)

7064 FURTHER RESULTS ON STABILITY OF A SWIRLING FLUID WITH VARIABLE DENSITY IN THE PRESENCE OF A CIRCULAR MAGNETIC FIELD. Pao, Hsien Ping (Catholic Univ. of America, Washington, D. C.). Phys. Fluids, 9: 2288-90(Nov. 1966).

A new branch of solution which corresponds to negative critical Taylor number is found for the stability of a swirling fluid with variable density in a circular magnetic field. Some clarification is made in the previously published results. (auth)

7065 EFFECT OF MAGNETIC FIELD ON THE LAMINAR RADIAL FLOW BETWEEN PARALLEL PLATES. Reddy, P. Govinda (Indian Inst. of Tech., New Delhi). J. Phys. Soc. Jap., 21: 2710-15(Dec. 1966).

The influence of transverse magnetic field on the laminar radial flow of an incompressible fluid between two closely spaced parallel plates was analyzed. The governing equations and boundary conditions are established, and a solution is obtained by perturbing the creeping-flow solution and making use of asymptotic expansion. The extent of the effect of magnetic field on the flow is determined by the magnitude of the Hartmann number, M. Numerical results for the pressure distribution are presented graphically. (auth)

7066 CONTINUUM FEEDBACK CONTROL OF A RAYLEIGH–TAYLOR TYPE INSTABILITY. Melcher, James R.; Warren, E. Paul (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 9: 2085-94(Nov. 1966).

The electrohydrodynamics of a highly conducting interface stressed by a perpendicular electric field and attached (by surface tension) to a rigid circular wall are described in terms of a set of normal modes which satisfy four boundary conditions. The interface can be unstable either because of gravity (a heavy fluid on top of a light fluid) or because of the electric field. The experimental eigenfrequencies, eigenfunctions, and conditions for instability are compared to the theory. These modes are then used to describe the dynamics when the interface displacement is detected and a proportionate potential is fed back to the segmented electrode which imposed the quiescent electric field. Electronic means for detecting interface disturbances are described, together with the relationship between the sampling scheme and possible overstability. A comparison of theory and experiment is made for the eigenfrequencies with feedback, and conditions for significant improvement in stability are given. (auth)

7067 HEAT TRANSFER FROM A FLAT PLATE IN MAGNETOHYDRODYNAMICS. Fillo, John A. (Univ. of Massachusetts, Amherst). Phys. Fluids, 9: 2102-5(Nov. 1966).

Subject to large magnetic Reynolds numbers, the heat transfer in a laminar boundary layer for flow of a viscous, electrically conducting, incompressible fluid past a semi-infinite flat plate is investigated. Attention is focused on the "cooling" problem; i.e., heat transfer in the boundary layer with a prescribed temperature difference between the plate surface and external stream. Viscous and Joule heating are neglected. The applied, free-stream magnetic field is coincident with the free-stream velocity field. Prandtl numbers of order one (slightly ionized gases) and of order 10^{-2} to 10^{-3} (highly ionized gases) as well as both large and small magnetic Prandtl numbers are included in the analysis. (auth)

7068 ELECTRICAL FIELDS IN MHD CHANNELS IN THE PRESENCE OF NEAR-ELECTRODE POTENTIAL DROP. Vatazhin, A. B. Prikl. Mat. Mekh., 30: 441-50(1966). (In Russian).

The influence of processes near the electrodes of the magnetohydrodynamic channels on the spatial distribution of various physical quantities is formulated and a number of solutions are provided. The electrode systems analyzed in this work are channels with nonconducting, nonparallel walls with certain sections consisting of conductors; various degeneracies are discussed and simplifying assumptions are enumerated permitting approximate solution of the problems. The presence of magnetic field gradients complicates the form of the solutions and it is shown that components of currents normal to the electrodes as well as parallel exist and thus modify the velocity profile. Physical and geometrical limitations of each of the solutions is described to define the range of applicability. This work is based on the theory developed by G. A. Lyubimov and draws on the results of experiments for justification of some of the assumptions necessary to make the problems tractable. (ATD)

7069 ON THE GEOMETRY OF STREAMLINES IN HYDROMAGNETIC FLUID FLOWS WHEN THE MAGNETIC FIELD IS ALONG A FIXED DIRECTION. Suryanarayan, E. R. (Univ. of Queensland, Brisbane). Proc. Amer. Math. Soc., 16: 90-6 (Feb. 1965).

Three-dimensional steady flows of inviscid magnetic fluids are discussed. It is assumed that the magnetic field is along a fixed direction. The main purpose was to investigate various dynamical and kinematical relations connecting the flow and the field quantities with the geometrical parameters of the streamlines. The expressions for the tangent, principal normal, and binormal vectors and the curvature and torsion of the streamlines are given in terms of the velocity components, the pressure, the density, and the magnitude of the magnetic field. The variations of the hydromagnetic pressure along the streamlines, along their principal normals and along their binormals were obtained. It was observed that the hydromagnetic pressure along the binormals remains constant. The Bernoulli function was defined and it was found that if this function exists then the Bernoulli surfaces contain both the streamlines and the vortex lines. An intrinsic relation satisfied by the Bernoulli function was determined and from this relation was obtained a necessary and sufficient condition for the Bernoulli surfaces to be a family of parallel surfaces. It was shown that the Bernoulli surfaces exist in the case of incompressible fluid and form the surfaces on which the sum of the fluid pressure, the kinetic energy and the magnetic energy is constant. In the case of isentropic flows, the variation of the fluid pressure along the streamline is expressed in terms of the Mach number, the magnetic field, the divergence of the unit vector along the streamlines, the density, and the magnitude of velocity. (BBB)

7070 INVESTIGATION OF THE STRUCTURE OF MAGNETOHYDRODYNAMIC FLOWS BY AN INDUCTION ANEMOMETER. Bolonov, N. I.; Kolovandin, B. A.; Skrinnik, E. F.; Povkh, I. L. (Donetsk State Univ., USSR. Donetsk Scientific-Research Inst. of Ferrous Metallurgy, USSR). Izv. Vyssh. Ucheb. Zaved., Energ., No. 1, 65-71(1966). (In Russian).

An instrument for investigating the structure of magnetohydrodynamic flows, an induction anemometer, is described. The principles of measuring the local velocity by the induction methods are given. The object of the investigation was a flow of a conduction fluid with a free surface situated in a comparatively strong magnetic field. The basic components of the experimental device were the liquid system, magnetic field source, and measuring equipment. The experiments carried out showed that the investigation of the advantages of the induction method of measuring the characteristics of turbulence and the design features of the induction anemometer which was used proved to be quite fruitful and offered considerable possibilities for a thorough investigation of the structure of MHD flows at sufficiently high Hartmann numbers. With the appropriate amplifying and measuring equipment the instrument on the whole is simple and reliable in operation. The obvious advantages of this instrument are: the possibility of investigating the structure of the flows of both ordinary and Newtonian fluids in a wide range of frequencies and its noninertia. A change of velocity fluctuation almost instantly causes a change of the induced emf. Finally, the design of the sensor permits a rigorous separation of the signals induced by various components of the fluctuating velocity. (ATD)

7071 PLANE JET OF A CONDUCTING GAS IN A TRANSVERSE MAGNETIC FIELD. Sokovishin, Yu. A. (Kalinin Polytechnic Inst., Leningrad). Izv. Vyssh. Ucheb. Zaved., Energ., No. 1, 72-6(1966). (In Russian).

The escape of a jet of conducting gas into a space with a transverse magnetic field is investigated. It is assumed that the conductivity of the escaping gas is constant. The equations for such

a flow are given along with appropriate boundary conditions. A formula is derived for finding the escape of a jet with an arbitrary value of the external magnetic field intensity. The results obtained can be easily generalized for the flow of a turbulent incompressible jet by using the Prandtl formula for the apparent kinematic viscosity. However, in this case it is necessary to assume that turbulence does not affect the conductivity of the moving gas. (ATD)

7072 ELEMENTS OF MAGNETOGASDYNAMICS. Kalikhman, L. E. Saunders Physics Books. Philadelphia, W. B. Saunders Co., 1967. 379p. $8.75.

Translated by Scripta Technica, Inc., from Elementy Magnitnoy Gazodinamiki.

The theory of magnetogasdynamics, various problems involved in the motion of plasma, the investigating methods employed, and selected applications are reviewed. Topics covered include: fundamental equations and boundary conditions of magnetogasdynamics; basic criteria of similarity; propagation of disturbances in plasmas; properties of ionized gases; and practical applications of magnetogasdynamics. (M.H.R.)

7073 TRANSONIC SIMILARITY RULE IN MAGNETOGASDYNAMICS. Kim, Rhyn H. Lansing, Mich., Michigan State Univ., 1965. 71p.

Thesis.

The present work is concerned with a similarity rule in the critical velocity flow regime of a gas considered to be a multifluid in an arbitrarily oriented electromagnetic field. The fluid in question is considered to be inviscid, non-heat-conducting, electrically conducting and perfect. It consists of electrons, ions and neutral particles. In the neighborhood of a thin body inserted into a fluid, there are introduced small perturbations. The fundamental governing equations, continuity, momentum, state the first law of thermodynamics, and that for the vorticity function (Crocco's equation) are based on the multi-fluid theory. Maxwell's equations are taken into account and by applying the principle of superposition, Maxwell's equations are combined with hydrodynamic equations to form the total system of governing equations. Equations of motion in the direction of the free-stream and in the direction vertical to the free-stream are combined by introducing the velocity function with the use of the continuity equation. There is obtained a differential equation for the velocity function which describes the flow approximately in the region of the critical velocity. The sytem of differential equations is approximated by the small perturbation technique in the neighborhood of the inserted body and of the critical velocity. The system of equations is transformed into a dimensionless coordinate system. By means of an appropriate combination in the intermediary system of algebraic equations, the coefficients of the differential system are assumed to be constant and invariant under the specially chosen transformation of coordinates. Having invariant coefficients which consist of such parameters as Mach number, electromagnetic field, thickness ratio, etc., we find the similarity rule of the flow in question. A limiting case of the present work presents the well-known von Karman transonic similarity rule. There is additionally considered a case where the magnetic field is parallel to the free-stream velocity. For illustrative purposes, a simple numerical example is calculated. Some relations between pressure coefficients of charged particle flow and variable parameters are given in forms of diagrams. (Dissertation Abstr.)

7074 ELECTRICAL PROPERTIES OF PLASMAS AND MAGNETOHYDRODYNAMIC POWER GENERATION. Poularikas, Alexander Demetrious. Fayetteville, Ark., Univ. of Arkansas, 1966. 155p.

Thesis.

The equivalent circuit of an ideal plasma is developed by assuming that the total drag on the electrons is caused by the ions, the induced currents are negligible and also that the magnetic field due to the conduction currents is negligible. It is also assumed that a steady state magnetic field is applied and thus the equivalent circuit parameters are found to be a function of electron and ion gyrofrequencies. Numerical results using the constants (electron density, magnetic field, etc.) found in the ionosphere show resonances in the impedance versus frequency characteristics. A plot of the resonance frequency versus the angle of the imposed magnetic field shows that the resonance frequency can be used, for example, to find the orientation of satellites with respect to the earth's magnetic field. The interaction of plasmas and magnetic fields is considered. The problem here is solved by assuming a ring type interaction between a plasma and current carrying ring. After integration the theoretical results are compared with experimental data with good agreement. (Dissertation Abstr.)

Geophysics

7075 (AD-633920) HIGH-ALTITUDE GUN PROBES (DEVELOPMENT OF LANGMUIR PROBES). Final Report. Block, A. V.; Kadis, A. L.; Smith, L. C. (GCA Corp., Bedford, Mass. GCA Technology Div.). Contract DA-19-020-AMC-00292(R). 68p. (GCA-TR-65-15-G). CFSTI $3.00 cy, $0.65 mn.

A program to develop an instrument capable of measuring electron density in the 50 to 160 kilometer altitude region and capable of surviving a 60,000 "G" shock encountered during launch from a cannon is described. The program is in two parts: The first describes various techniques and instruments capable of measuring electron density in this altitude region. The second describes the design techniques as well as flight results from these probes. Both dc and ac Langmuir probes were chosen as the best instruments for fulfilling the system requirements. (auth)

7076 (AD-636415) UPPER ATMOSPHERE RESEARCH USING AIRCRAFT. Special Reports. Gassmann, George J.; Pittenger, Eugene W. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Apr. 1966. 61p. (AFCRL-SP-44; AFCRL-66-292). CFSTI $3.00 cy, $0.65 mn.

An existing airborne installation is described and its potentialities are outlined. The particular properties of a jet aircraft (movability, speed, altitude) combined with appropriate ionospheric sounding equipment (receivers, optical apparatus, magnetometer, and cosmic ray recorders) constitute a unique capability. After reviewing past results obtained from more limited airborne equipment, an outline of operations and objectives is given, pertaining to: magnetic shell propagation, arctic radio physics, eclipse effects, dumping of trapped electrons, equatorial electrojet, nuclear detonation effects, ionospheric drifts, airglow and cosmic ray surveys. (auth)

7077 (AD-636675) POLAR OBSERVATIONS OF SOLAR COSMIC RAY EVENTS DURING THE IQSY. Report No. Douglas Paper-4066. Goedeke, A. D.; Masley, A. J.; Adams, G. W. (Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.). 1966. Contract NSF-C-393. 26p. CFSTI $3.00 cy, $0.65 mn.

During the period of the IQSY, January 1964 through December 1965, the sun remained quiet, producing very few energetic particles. There were many instances during the IQSY when low-energy detectors on satellites and space probes registered small intensity increases. However, a few of these "events" were associated with protons of energies exceeding 10 MeV. Moreover, the maximum intensities (of $E_p > 500$ keV) are typically 1-8/sq cm sec ster. Most of these events were below the threshold of riometer detection. The largest solar cosmic ray event observed in 1964 by polar-based riometers was that of March 16. This event was observed by 30 and 50 Mc/D riometers at McMurdo, Antarctica, and Shepherd Bay, N.W.T., Canada. The largest event in 1965 occurred on February 5 and was the largest during the IQSY. It was associated with a class 2 flare at about 1750 UT, February 5. The propagation time between the sun and earth was about one hour. This event was well observed by satellites, space probes, and riometers. The February 5, 1965 event is discussed primarily. Some discussion was given to the March 16, 1964 event, other small events during the IQSY, and the recent event in March 1966. (auth)

7078 (AD-636964) DETERMINATION OF THE DIURNAL VARIATION OF THE AURORAL BELT BY RADIO MEANS. Scientific Report. (Alaska Univ., College. Geophysical Inst.). Sept. 1965. 35p. (UAG-R-170). CFSTI $3.00 cy, $0.65 mn.

Backscatter echoes in the high-frequency portion of the radio spectrum exhibit a systematic southward movement in the evening and northward in the morning. Typically, the scattering belt lies about 78°N geomagnetic latitude during the day, and moves south to 65 to 70° at night. The extent of the southward movement correlates strongly with geomagnetic activity and, to a lesser degree, local time. No significant difference was found between summer and winter diurnal variations of the scattering belt. The scattering belt was found to include the optical auroral belt; thus, it is concluded that there is no significant difference in the diurnal variation in the position of the summer and winter auroral belts for given levels of magnetic disturbance. The scattering belt was present on the College magnetic meridian during most of the two and one-half years' observations. This is interpreted as showing the optical auroral belt existed most of the time somewhere on the College meridian, and hence on others as well. Thus, the auroral belt during the solar activity minimum period existed as a more or less closed curve around the geomagnetic pole. When the latitudinal effects are considered versus local time, the auroral belt takes the form of an oval curve, the northernmost portion approximately on the noon meridian. The size of the oval at any time is proportional to the size of the disturbance. (auth)

7079 (AD-637004) APPROACH TO STEADY-STATE IONIZATION IN AIR. Report No. 2-12-66-3. Kaufman, Alfred M. (Lockheed Missiles and Space Co., Palo Alto, Calif. Research Labs.). May 1966. Contract Nonr-3368(00). 43p. CFSTI $3.00 cy, $0.65 mn.

The deionization equations which describe the time history of electrons, positive and negative ion populations are a familiar topic to workers in the field of upper atmospheric physics. The common procedure with these equations has been to assume slow variation in the equation parameters. Then the population of each species is adequately described by a quasi-equilibrium value which also varies slowly with time. What, in effect, is used then is a steady-state approximation. The response of the system to transient rapid parameter variation or initial large departures from equilibrium are thus ignored. Unfortunately, the transient response of the system cannot always be neglected without seriously misrepresenting the physics. Therefore, it would be useful to know when such a neglect of transients can be justified. The main goal is to present graphically for a series of altitudes between 0 and 100 km the information necessary to give a firmer basis for the decision to neglect transients. Included in the information presented within are the quasi-equilibrium concentrations of electrons and negative ions as well as various time constants associated with the deionization equations. All information is parametrized according to ionization rate which varies between 10 and 10^{12} ion pairs/cm^3. The altitude dependence is obtained from the 1959-ARDC model atmosphere and normal atmospheric chemistry is assumed throughout. (auth)

7080 (AD-637871) INVESTIGATION OF MAGNETOHYDRODYNAMIC WAVE PROPAGATION IN THE IONOSPHERE AND COLLISIONAL EFFECTS OF POSITIVE IONS WITH NEUTRAL PARTICLES. Final Report, April 6, 1965-August 14, 1966. Kahalas, Sheldon L.; Knabe, Walter E.; Murphy, Brian L.; Parker, Lee W. (Mount Auburn Research Associates, Inc., Cambridge, Mass.). Aug. 15, 1966. Contract AF 19(628)-5133. 161p. CFSTI $3.00 cy, $0.65 mn.

The propagation of MHD waves above the E region of the ionosphere is treated with the aim of developing a computer program to predict the space-time history of MHD waves generated by a given source. Changes in ionization density as a function of altitude and the geomagnetic field in the form of a magnetic dipole are incorporated. The Carovillano-McClay method of solution (expansion in vector spherical harmonics) was used. This leads to a set of coupled, second-order, ordinary, differential equations to solve. Boundary conditions, for the case where the ionospheric plasma is treated as a cavity bounded by vacuum, are derived. Some preliminary numerical calculations, for a source consisting of an axisymmetric ring current located over the magnetic pole, are presented. The coupling of wave modes due to the Hall effect is discussed. The physics of positive ion-neutral particle collisions, important in the propagation of MHD waves in the E region, has been considered from the point of view of possible modifications to the hydrodynamic equations. Corrections to the hydrodynamic moment equations due to space-time correlation effects have been investigated by the theory of Green and found to be small. Corrections to the adiabatic pressure relations due to the interaction of the positive ions with the neutrals are considered and found to be significant for the propagation of MHD waves through the E layer. Various forms for the correction terms as they effect the momentum equations have been derived but no detailed calculations are carried out. (auth)

7081 (N-66-27213) RECOMBINATION IN THE NIGHTTIME F-REGION FROM INCOHERENT SCATTER MEASUREMENTS. Nisbet, J. S.; McCrory, D. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). 1965. 15p. (NASA-CR-57303). CFSTI $3.00 cy, $0.65 mn.

Measurements of recombination coefficients in the F layer were made using ion density profiles derived from reduced ionograms. Uncertainties resulted due to the lack of information on the profile of the top of the layer, on the temperatures of electrons, ions, and neutral particles and about the profiles in the lower F layer at night. Profiles obtained are used to study the nighttime recombination. It is shown that large changes in the electron ion temperature ratio do occur at night in winter under low sunspot conditions up to about 0200 hours. A considerable improvement in the consistency of the results is obtained from the use of the incoherent scatter measurements and it is possible to derive recombination coefficients with reasonable agreement from hour to hour from twenty minutes of data. Electron-ion temperature ratios of greater than unity were observed throughout the night raising the question of nighttime production and the effect of this on the results is discussed. (auth)

7082 (ORNL-TM-1702) STRONG, PLANE SHOCK WAVES IN AN INHOMOGENEOUS ATMOSPHERE. Dresner, Lawrence (Oak Ridge National Lab., Tenn.). Dec. 1, 1966. Contract W-7405-eng-26. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Theory is presented for the propagation of strong shocks produced by explosions. First, propagation in a homogeneous atmosphere is considered, and then the inhomogeneous atmosphere without and with gravity is treated. Equations are derived for the overpressure and position of the shocks. It is concluded that for air, the effects of gravity can be neglected in the strong-shock region. (D.L.C.)

7083 (ORNL-TM-1703) WEAK, PLANE BLAST WAVES. Dresner, Lawrence (Oak Ridge National Lab., Tenn.). Dec. 1, 1966. Contract W-7405-eng-26. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Theory is developed for a weak explosion in a homogeneous atmosphere and in an isothermal atmosphere in a gravitational field. Graphs of overpressure vs distance are given. (D.L.C.)

7084 (AD-638326) COSMIC RESEARCH. Translated from Kosm. Issled., 4: No. 2, 179-335(1966). 282p. (FTD-HT-66-244). CFSTI $3.00 cy, $0.65 mn.

This translation was made to provide the users with the basic essentials of the original document in the shortest possible time. It has not been edited to refine or improve the grammatical accuracy, syntax, or technical terminology. Papers are included on artificial earth satellites, ionospheric properties, meteorite penetration, radiation belts, and cosmic rays. (W.D.M.)

7085 THE CONTRIBUTION TO THE FORMATION OF THE POLAR F2 REGION THROUGH PHOTOIONIZATION OF OXYGEN BY GRAZING SOLAR RADIATION AT GREAT HEIGHTS. Kamiyama, Hiroshi (Tohoku Univ., Sendai). Sci. Rep. Tohoku Univ., Fifth Ser., 18: 1-15(July 1966).

It is assumed that the electron density distribution is controlled by photoionization, losses due to chemical processes, and diffusion along lines of geomagnetic force. The resulting general equation for the electron density distribution is applied to conditions in the polar region where, in the winter, solar ionizing radiation cannot illuminate the F region but grazes the atmosphere at great heights. In an atmosphere with a constant temperature of 1275°K, electrons produced through photoionization of atomic oxygen in such higher regions diffuse with oxygen ions down to the F region and make a contribution to the formation of a F2 peak. The results show that the F2 peak appears at about the 400-km level regardless of the height of photoionization. The contribution to the peak electron density in this manner is estimated to be 3.32×10^2 cm^{-3} for the solar zenith angle $\chi = 113.5°$, 8.32×10^4 cm^{-3} for $\chi = 103°$, and to be comparable with the observed electron density of the order of 10^5 cm^{-3} at latitudes where $\chi < 102°$. Discussions are given of the various additional mechanisms which possibly contribute to the formation of the polar F2 region. (auth)

7086 THE RELATION BETWEEN THE GEOMAGNETIC STORMS AND THE INTERPLANETARY SECTOR STRUCTURE. Sakurai, Tohru (Tohoku Univ., Sendai). Sci. Rep. Tohoku Univ., Fifth Ser., 18: 51-64(Nov. 1966).

The essential condition responsible for causing the geomagnetic disturbances at and near the minimum stage of solar cycle is studied. The data of the interplanetary magnetic field and the incident solar ion current by IMP-1 are used. And further the geomagnetic index, K_p, and the photospheric magnetic field data are also used. The results are as follows: (1) geomagnetic storms occur almost simultaneously when the earth is passing across the sector boundary; (2) geomagnetic storms are caused by the impact of the solar wind plasma upon the earth's magnetosphere; (3) the region of the sector boundary on the sun is corresponding to the region of the weak magnetic field; (4) this region of weak magnetic field in the neighborhood of the sector boundary on the sun would be the source region of the emission of the solar energetic plasma corresponding to the geomagnetic storms; (5) the sector boundary in the interplanetary field forms the simple contact surface at the quiet time, and when it is disturbed it seems to become growing to the turbulence; and (6) the asymmetric feature in the activity of the four sectors is shown at the declining phase of the solar cycle, but this feature becomes less evident at the minimum stage of the solar cycle. (auth)

7087 FREQUENCY ANALYSIS OF THE GEOMAGNETIC PULSATIONS. Kato, Yoshio; Aoyama, Iwao; Toyama, Fumio; Morioka, Akira (Tohoku Univ., Sendai). Sci. Rep. Tohoku Univ., Fifth Ser., 18: 65-76(Nov. 1966).

Geomagnetic pulsations were continuously recorded on a magnetic tape at Maui Island, Hawaii (geomagnetic coordinate; 21°42'N, 265°36'W) in the period from 16th to 31st May 1965, using the induction magnetometer. The geomagnetic pulsations, which were recorded on the magnetic tapes, are reproduced through the band pass filters. The difference of the frequency band of each channel is half octave, and the central frequency of the filters are from 1 cps to 96 cps. Analyses were made of the frequency of the geomagnetic pulsations of pc's (continuous pulsations) and also pi's (irregular type pulsations), and the characters of these geomagnetic pulsations were found. (auth)

7088 HEIGHT PROFILE OF THE Sq CURRENT IN THE MIDLATITUDE IONOSPHERE. Kamiyama, Hiroshi (Tohoku Univ., Sendai). Sci. Rep. Tohoku Univ., Fifth Ser., 18: 77-83 (Nov. 1966).

Under the assumption that the ionospheric Sq current flows only in the horizontal direction, the height distribution of the current intensity is calculated as a function of the direction of an electrostatic field, for a location at 20° of the geomagnetic latitude. The result shows that the height profile of the current is subtly depending on the direction of an electric field; the maximum current being sometimes near the E-peak, and sometimes in the region between 120 and 130 km. Remarks are made on the change in the magnetic field, detectable by a rocket-borne magnetometer, as it passes through the region where currents flow. (auth)

7089 A FORTY-ELEMENT CIRCULARLY POLARIZED ARRAY AT 1500 kc FOR IONOSPHERIC RESEARCH. Dean, K. G. AWA (Amalgamated Wireless Australasia Ltd.) Tech. Rev., 13: 103-40(1966).

A circularly polarized array for ionospheric research is described which contains 40 horizontal half-wave dipoles mounted on 25 90-ft wooden poles arranged in a square matrix. The aerial consists of 2 plane-polarized 20-dipole arrays which are at right angles and fed in phase quadrature with respect to one another. Each 20-dipole array is driven by its own open-wire transmission line system, which commences at the corner of the aerial as a 20-wire cross-fed trunk line and which branches at the center of the array into 4 cross-fed 4-wire lines, which divide later, and two 2-wire lines; each 2-wire line is used to end feed a pair of dipoles. For each plane wave aerial, the total transmission line lengths from the transmitter to each dipole pair are identical, and the whole aerial arrangement is symmetrical with respect to the matrix of support poles. The methods of adjustment are described and the performance obtained as a result of these adjustments is discussed. (BBB)

7090 REFLECTION OF RADIO WAVES FROM STRATIFIED PERTURBED IONOSPHERIC PROFILES. Burman, R. (Victoria Univ., Wellington). IEEE (Inst. Elec. Electron. Eng.) Trans. Antennas Propagation, AP-14: 661-2(Sept. 1966).

Reflection of radio waves from an ionosphere with a perturbed electron density profile is considered. Some approximate formulas are presented which give the effect of the perturbation on the reflection coefficients. Earlier studies considered the reflection of radio waves from a planar stratified ionosphere when a Gaussian height distribution of electron density or conductivity is superimposed on an exponential variation of conductivity. In a treatment of ionospheric reflections from perturbed profiles using numerical methods, the logarithm of the electron density was increased by a Gaussian function of height. In the present study the ionospheric electron density profile was taken to consist of an unperturbed profile, for which the field distribution with height is assumed known, upon which is superimposed a perturbation. Both the unperturbed and perturbed profiles are functions of height only. The effect of the perturbation on the reflection of radio waves was studied by using some results of Pitteway, who considered reflection from a planar stratified ionosphere modified by weak irregularities. (BBB)

7091 EXISTENCE OF ECHOES FROM UNUSUAL WHISTLERS. Norinder, Harald; Knudsen, Edgar (Univ. of Uppsala). Ark. Geofys., 5: 63-6(1966).

It was noted in the course of ionosphere studies that, during periods of whistler activity, both usual and unusual whistlers sometimes occur which permit excellent opportunities of comparison. Series of up to 10 echoes were simultaneously identified originating both from usual and unusual whistlers. The good agreement obtained between the time intervals of the 2 types indicated that the unusual whistlers follow the same propagation paths between the hemispheres as the usual whistlers and both may give rise to series of echoes. The possibility of unusual whistlers being generated in the exosphere was also investigated. Assuming that the unusual whistlers are generated in the exosphere, part of the energy should be propagated along the magnetic lines of force to the northern hemisphere and part to the southern hemisphere. This generation process should thus always give rise to subsequent double echoes. However, when all the recordings were examined, no double echoes were found, which indicates that the unusual whistlers were generated in the exosphere. Up to now it has been possible to record only one type of unusual whistlers, namely the risers, during a relatively short time interval. Under these circumstances it was not possible to draw any general conclusions concerning the mechanism by which whistlers are generated. (BBB)

7092 HARMONIC ANALYSIS OF THE DAILY VARIATION OF CRITICAL FREQUENCY OF THE F2 LAYER OF THE IONOSPHERE. Singler, Anton (Heinrich-Hertz-Institut fuer Schwingungsforschung, Berlin-Adlershof). Beitr. Geophys., 74: 271-84(1965). (In German).

The occurrence of fluctuations in the electron density in various ionospheric layers as a function of solar activity is discussed on the basis of daily, yearly, and geographical variations. The diurnal variations of the ionospheric F2 layer critical frequencies were studied during one sunspot cycle to obtain information on their dependence on season and solar activity. By expanding the diurnal variations into a Fourier series, mean and variations could be separated. The results show that the form of the daily variation changes continuously with season and solar cycle, and that it can be described in fair approximation by a simple empirical interpolation formula. Mathematical derivation of this formula is outlined and the model described. (BBB)

7093 THEORY OF RADIATIVE TRANSFER IN A NONUNIFORM MEDIUM. Zheleznyakov, V. V. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 1057-64(1966). (In Russian).

The conventional radiative transfer equation in a nonuniform medium is derived from the equation of continuity for the density of radiative energy in six-dimensional coordinates and group-velocity space. The theory of radiative transfer in a nonuniform medium proposed by Oster is shown to be incorrect especially when it is applied by Oster and Sofia to the investigation of the radio emission of the quiet Sun. (auth)

7094 STATISTICAL CONSIDERATIONS ON THE FREQUENCY AND PATTERN OF STRONG IONOSPHERIC DISTURBANCES. Singler, Anton (Henrich-Hertz-Institut, Berlin-Adlershof). Beitr. Geophys., 75: 34-44(1966). (In German).

Temporal and geographic variations in the electron density of the F2 layer of the ionosphere are discussed, and the frequency of intense ionospheric disturbances observed in the time interval from 1957 to 1964 was investigated on the basis of ionospheric data obtained at Juliusruh/Ruegen (ϕ = 54°38′; λ = 13°28′). Statistical results on the monthly number of disturbances are analyzed. As parameters, the midday mean and the night-time min value of the ordinary component of F2-layer critical frequency were subjected to scrutiny. For calculation of probability distribution, the Poisson formula was used. The results offer a means for prediction of disturbances in short-wave radio propagation. The probability that single strong disturbance will last more than 1 day, on the basis of the 1957 to 1964 data, was $p = 0.252 \pm 0.099$. The probability that a negative disturbance will be accompanied by a positive phase was $p = 0.196 \pm 0.093$. (BBB)

7095 ROCKETS AND THE AURORA BOREALIS. Fastie, W. G. (Johns Hopkins Univ., Silver Spring, Md.). APL (Appl. Phys. Lab.) Tech. Digest, 5: 5-10(May-June 1966).

Auroral studies conducted with 4 Aerobee rockets, all of which were fired into active auroral discharges, and all of which provided information about the auroral process, are described. Instrumentation used on each of these flights and the results obtained are reported. The first experiment took place in February 1960 and was designed as an engineering test flight of the spectrometric equipment and a survey of the short-wavelength region for guidance in planning future rocket experiments. This rocket obtained the first far-uv spectrum of an aurora in an Intensity III display. A composite spectrum obtained from this flight is shown and the results summarized. An experiment made in February 1965 obtained the very short wavelength uv spectrum in much greater detail, than previous experiments, from an Intensity II aurora. A 7.5-sec telemetry trace of the far-uv spectrum from 1050 to 1550 Å shows many atomic and molecular emissions which can be clearly identified. The most spectacular feature of the spectrum was the unresolved 1304 Å resonance lines of atomic oxygen. The instrumentation for the February 1966 experiment included a secondary electron spectrometer (40 to 900 eV), and a primary electron sensor (>1000 eV) that scanned through 180° of elevation every 10 sec. Measurements of the primary electron flux were obtained over the full solid angle of 4π steradians. Preliminary results showed that the angular distribution of primary electrons is a max at 90° to the earth's magnetic field lines, that the energy distribution of secondary electrons is exponential over the energy range from 40 to 900 eV, and that there were significant differences in the height profiles of some of the atomic and molecular emissions. This last rocket carried a more sophisticated payload, including, in addition to a uv spectrometer and visible photometer, a far-uv photometer, an ir photometer, an electron spectrometer, and a spatial resolving primary flux analyzer. (BBB)

7096 DIRECT OBSERVATION OF ELECTRON DENSITY IN THE IONOSPHERE. II. Rawer, Karl (Univ., Freiburg i. B. Deutsche Bundespost, Fernmeldetechnisches Zentralamt, Breisach-am-Rhein, Ger.). Sci. Ind. Spatiales, 2: 49-54(1966). (In German).

A description is given of three tests with rockets. A method is described for determining the electron content, i.e., the integrated

value of the electron density between a ground transmitter and a receiver on board the rocket, two harmonic frequencies being transmitted and received on board. A pulse is obtained which corresponds to the difference of the Doppler effects on the two frequencies. By this method the kinematic effect is eliminated, and only the plasma effect remains. The method is highly sensitive, and makes it possible to determine profiles not detectable by sounding with ground-based apparatus. (Int. Aero. Abstr.)

7097 RELATIONS BETWEEN THE OPTICAL AND ELECTRICAL PROPERTIES OF IONOSPHERIC LAYERS. Dietze, G.; Kohl, G. (Meteorologisches Observatorium, Dresden). Z. Meteorol., 18: 212-18(1966). (In German).

A discussion is presented on verification of a relation established by other authors between skylight polarization during twilight and the critical frequency of the E layer. The relation is checked with the aid of extensive experimental evidence, with particular reference to simultaneous optical and electrical effects of interplanetary dust in the upper atmosphere. A tabular comparison of twilight-optical and ionospheric parameters reveals no significant correlation. (Int. Aero. Abstr.)

7098 USE OF SATELLITE SIGNALS TO INVESTIGATE THE POLAR IONOSPHERE. Titheridge, J. E. (Univ. of Auckland, New Zeal.). Polar Rec., 13: 7-15(Jan. 1966).

A review is presented of the effects the polar ionosphere has on orbiting satellite-transmitted radio signals as received at three ground stations in the Antarctic. The satellite involved is the NASA Polar Ionosphere Beacon satellite (S-66), transmitting continuously on frequencies of 20, 40, 41, and 360 Mc at a power level of 250 mW. Most extensively reviewed are results obtained at the "Scott Base," (lat. 77° 51′ S, long. 166° 44′ E), which is 2.4 km east of the American supply station at McMurdo Sound. Satellite signals are received on four horizontal dipole antennas supported 2 ft above the ground. An automatic system is described which recorded one week's transits (about 100). Frequency, antenna orientation, and filter time constant are listed. It is found that the Beacon linearly polarized signal is split into two circularly polarized components. Samples of the recorded data are presented. (Int. Aero. Abstr.)

7099 SIMULTANEOUS MEASUREMENTS OF AURORAL X RAYS AT KIRUNA (SWEDEN) AND IVALO/SODANKYLA (FINLAND) FROM JULY TO SEPTEMBER 1965. Ehmert, A. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.); Kremser, G.; Pfotzer, G.; (and others). SPARMO Bull., 10-28(June 1966).

A discussion is presented of the time structure of the x-ray events at two locations of simultaneous balloon flights (Kiruna, Sweden, and Ivalo/Sodankylä, Finland). The temporal and spectral changes and the spatial variations of the x-ray precipitation in a rather restricted area are investigated. (Int. Aero. Abstr.)

7100 ENERGY VARIATIONS OF AURORAL ELECTRONS ACCORDING TO BALLOON MEASUREMENTS. Bewersdorff, A. (Laboratoire de Physique Cosmique, Meudon, France); Dion, J.; Legrand, J. P.; Keppler, E.; Kremser, G.; Riedler, W. SPARMO Bull., 29-35(June 1966).

An analysis of numerous balloon flights at Kiruna (Sweden) showed that the average energy spectrum of auroral X rays in the range from 20 to 150 keV shows a remarkable diurnal variation. Soft spectra are observed in the early morning hours and a gradual hardening takes place in the course of the day (until 17 hr LT). Around geomagnetic midnight (breakup region) very different spectra occur; soft and hard ones were found. The influence of absorption in the atmosphere is estimated and it is shown that the variation must principally be due to a similar diurnal variation of the spectrum of the primary auroral electrons. In some cases relations seem to exist between the spectrum and other features of particle precipitation events (as time dependence of intensity, morphology). (auth)

7101 ON THE RELATION BETWEEN THE E-LAYER AND THE SUN. Serafimov, K. (Geophysical Inst., Sofia). Beitr. Geophys., 75: 222-30(1966).

Some expressions are deduced for the variations of the E layer critical frequency conditioned by the solar zenith angle, taking into account the influence of the transport, the gradient and the variations with time of the height scale. Taking into consideration the seasonal changes of the recombination coefficient and the height scale it is theoretically confirmed that the daily value of the index n of the cosine law for the E layer does not coincide with the noon value. The theoretical analysis is illustrated with data for n taken from the Dourbes station. The results show a very small dispersion for n dependent on the season (having its maximum during summer and minimum during winter). A decrease of n in the noon period was observed mainly in summer. A forenoon decrease of f_0E was observed at $\chi = 70$ to 82°. The n determined on the basis of forenoon values of f_0E often differs from that based on the afternoon values. Values between 0.3 and 0.37 were obtained. The juxtaposition of data for Dourbes and Sofia ($n = 0.21$ to 0.4) shows the influence of the site at which the measurements were taken as regards the S_q current system. The n values agree with the solar x-ray emission in the range λλ (44 to 60 Å) (the correlation coefficient being 0.82). The following relationship could be used for n: $\bar{n} = a(1 + b\,\bar{F})$. For Sofia $a = 0.1$, while for Dourbes $a = 0.19$. For both stations $b = 0.53$. (auth)

7102 SEASONAL VARIATION OF GEOMAGNETIC DISTURBANCE AMPLITUDES. Roosen, J. (Univ., Utrecht). Bull. Astron. Inst. Neth., 18: 295-305(July 1966).

The semiannual variation in geomagnetic disturbance amplitudes is shown to consist of an essentially one-to-one correspondence between the average daily amplitude index A_p and the solar declination. Average A_p is not a unique function of the heliographic latitude of the earth. The difference in modulation depths of the variation between low- and high-disturbance levels disappears if log A_p is considered. This offers a possibility of determining for every disturbance amplitude the value it would have attained if solar declination had been zero. The modulation depth of the variation is shown to be independent of the latitude of the solar activity zones, i.e., of the phase of the solar cycle. The variation of recurrent ("M region") disturbances does not differ from that of all disturbances. These results strongly support the "equinoctial hypothesis" for the explanation of the semiannual wave. (auth)

7103 MEASUREMENTS OF TOTAL ELECTRON CONTENT OVER AHMEDABAD AND BOMBAY FROM BEACON SATELLITE DATA. Shirke, J. S.; Ramakrishnan, S. (Physical Research Lab., Ahmedabad, India). Proc. Indian Acad. Sci., Sect. A, 63: 338-48(June 1966).

A method is outlined that was used at Ahmedabad for determining the total electron content in the ionosphere from differential Faraday rotations of plane-polarized radio waves on 40.010 and 41.010 Mc transmitted by NASA satellite 1964-64A. The observations made during the period October 1964 to April 1965 are utilized to determine the diurnal variation of the total electron content up to the satellite height which was about 1000 km over Ahmedabad and Bombay latitudes. The curve of total electron content up to the satellite height shows similarity to the curve of maximum electron density at the F2 peak. The total electron contents over Bombay are in general higher than those over Ahmedabad. (auth)

7104 ONSET OF SUDDEN COMMENCEMENTS AS A FUNCTION OF SOLAR ACTIVITY. Schroeder, W. Beitr. Geophys., 75: 231-6(1966). (In German).

The relation between 27 sudden commencements, the solar activity and the geomagnetic conditions (K_p) during the years 1963 and 1964 are investigated. It is shown that 15 SSC are associated with small K_p Index ($K_p \leq 4$). The results are compared with the relations between the solar wind and the magnetosphere. (auth)

7105 MEASUREMENTS IN THE RADIATION BELTS AND ARTIFICIAL ION CLOUDS AT AN ALTITUDE OF 2000 KM. Haser, L. (Max-Planck-Institut fuer Physik and Astrophysik, Garching, Ger.). Sterne Weltraum, 5: 166-7(July 1966). (In German).

A German-French high-altitude rocket experiment carried out over the Sahara desert in April 1966 is described. Several particle measurement experiments were conducted in the inner radiation belt, at altitudes up to about 2000 km. Two barium-vapor ion clouds were released and observed. (Int. Aero. Abstr.)

7106 ROCKET MEASUREMENTS OF THE VISIBLE DAYGLOW. Zipf, Edward C. Jr. (Univ. of Pittsburgh). J. Geomagnet. Geoelec., 18: 301-31(1966).

Recent rocket measurement of the spectrum and altitude distribution of the visible dayglow are reviewed. The current theory of the dayglow is discussed in the light of these data and the results of new laboratory studies on atomic processes of aeronomic interest. The important role played by solar radiation in the excitation of the visible dayglow is illustrated in a detailed discussion of the emission of the (0,0) negative band of N_2^+ and the red line (6300 Å) of atomic oxygen in the dayglow. (auth)

7107 ANALYSIS OF POLAR MAGNETIC STORMS. Kern, John W. (Univ. of Houston, Tex.). Contract NASr-21. J. Geomagnet. Geoelec., 18: 125-31(1966).

An approximate method for analyzing broad-scale current systems in the ionosphere is outlined which allows calculation of sources and sinks of current from surface observations. Such sources and sinks of ionospheric current have been suggested in connection with models for geomagnetic disturbance phenomena. Usual analytic methods yield only divergence-free current systems. The treatment of these current systems by the methods outlined yields the desired divergences of the sheet-current in the ionosphere. (auth)

7108 DEVELOPMENT OF GEOMAGNETIC AND AURORAL STORMS. Akasofu, Syun-Ichi (Univ. of Alaska, College). J. Geomagnet. Geoelec., 18: 109-23(1966).

The development of the main phase of geomagnetic storms and of magnetic and auroral substorms is examined on the basis of analyses of individual geomagnetic storms. Several important aspects of geomagnetic storms revealed in this study are reported and discussed. (auth)

7109 PROPAGATION OF THE PRESSURE WAVES PRODUCED BY AURORAS. Maeda, K. (Goddard Space Flight Center, Greenbelt, Md.); Young, J. M. J. Geomagnet. Geoelec., 18: 275-99(1966).

As shown in a previous paper by Maeda and Watanabe, periodic heating around the E region in the polar upper atmosphere by auroral particles can be regarded as the source of very long acoustic-type atmospheric pressure waves observable at the ground. It was shown, however, that these pressure waves attenuate rapidly outside the source in the isothermal atmosphere. On the other hand, in the actual atmosphere, these waves propagate horizontally through the ducting, which consists of two channels, corresponding to the atmospheric temperature minima at the mesopause and the tropopause, respectively. It is shown that for the propagation of 100-sec waves, the upper channel is effective in summertime, while the lower one is effective in winter in the polar upper atmosphere. It is also shown that the traveling pressure waves associated with auroral activity are not necessarily limited in the acoustic mode, but sometimes extended to gravity (thermobaric) mode. This is partly due to the existence of large positive lapse rates layers such as upper part of stratosphere and in the thermosphere. As a consequence, clear sinusoidal oscillations, which appear occasionally with periods of group velocity minima (around 5 min), can be ascribed to Airy phase. As an example, the data obtained at the NBS stations in Washington, D. C. on July 15, 1960 are shown with its preliminary results of power spectrum. (auth)

7110 RECENT INVESTIGATIONS OF HYDROMAGNETIC EMISSIONS. PART II. THEORETICAL INTERPRETATION. Wentworth, R. C. (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Geomagnet. Geoelec., 18: 257-73(1966).

Recent experimental and theoretical work suggests the hypothesis that hydromagnetic (hm) emissions are hydromagnetic wave packets guided by field lines as they bounce back and forth between hemispheres of the earth. As such they are analogous to whistlers, and one test of the hypothesis is the quantitative calculation of plasma densities in the outer magnetosphere and their comparison with whistler densities closer to the earth. Many hm emissions exhibit measurable dispersion when displayed in the form of sonagrams (frequency vs time displays). In such cases, the measurement of group bounce times at two different emission frequencies can be combined with an accurate model of the magnetosphere to determine the zero-frequency (Alfvén) bounce period and the equatorial cyclotron frequency above which the wave cannot propagate. These two quantities uniquely define the field line along which the hm emission propagated and the integrated plasma density along that field line. Analysis of 9 events showed they occurred on field lines crossing the equatorial plane between 4 and 10 earth radii, and showed equatorial plasma densities in agreement with extrapolated whistler "knee" densities. (auth)

7111 RECENT INVESTIGATIONS OF HYDROMAGNETIC EMISSIONS. PART I. EXPERIMENTAL OBSERVATIONS. Tepley, L. R. (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Geomagnet. Geoelec., 18: 227-56(1966).

A review is presented of some of the more important properties of Pc 1 (0.2 to 5 cps) emissions observed at middle and low latitudes. Special attention is given to fine-structured regular oscillations referred to by various workers as pearls, type A oscillations, and hydromagnetic (hm) emissions. The following aspects of these oscillations are discussed: (a) Signal Appearance. The emissions are considered from both their amplitude–time (waveform) appearance observed on chart records and their frequency–time (f–t) characteristics observed on sonagrams. The various types of f–t fine structure are discussed (rising and falling frequency elements, fan-shaped elements, etc.). (b) Simultaneity of Occurrence at Widely Separated Locations. A high degree of similarity is often found in the appearance of f–t structural elements of hm emissions recorded simultaneously at widely separated stations. Attention is given to the time shifts between these elements at stations in the same hemisphere and in opposite hemispheres. (c) Times of Occurrence. Correlations are considered between times of occurrence of hm emissions and other geophysical effects such as charged particle events, magnetic storms, and variations of the ionospheric parameter F_0F2. (d) Latitude Effects. Various latitude-dependent emission characteristics are discussed. These include latitude variations of emission frequency, fine structure repetition period, and signal amplitude. In addition to the aspects of the Pc 1 emissions outlined above, properties of two other types of emissions are briefly discussed. One of these signals, referred to here as a "continuous emission" also lies in the Pc 1 category. It is often observed continuously throughout the night and is characterized by a slow variation of f–t characteristics. The other signal, which might be placed in a Pc 1–Pi 1 transition category, is observed during magnetically disturbed periods. On sonagrams it is characterized by an irregularly spaced rising frequency fine-structure. When monitored aurally on time-compressed magnetic tape (speedup factor of 1000 to 2000), it is characterized by a sound similar to bubbles blown under water. (auth)

7112 SOLAR FLARE EFFECT ON THE GEOMAGNETIC FIELD. Nagata, Takesi (Tokyo Univ. Univ. of Pittsburgh). J. Geomagnet. Geoelec., 18: 197-219(1966).

Reviewing important classical results of studies on the geomagnetic solar flare effect (s.f.e.), it is confirmed that the geomagnetic s.f.e. is a temporary augmentation of the geomagnetic daily variation field in the sunlit hemisphere. By taking into account the electromagnetic induction within the ionosphere, it is then stressed that the geomagnetic s.f.e. be considered as a transient phenomenon in the ionosphere having about 5×10^{-8} emu in integrated conductivity. Results of analyses of global distribution of 15 typical s.f.e.'s during the IGY have shown that (a) an almost perfect simultaneous relationship holds among optical and radio solar flares, geomagnetic s.f.e.'s and sudden ionospheric disturbances; (b) a geomagnetic s.f.e. of small amplitude takes place in the dark hemisphere always simultaneously with an s.f.e. in the sunlit hemisphere; and (c) the maximum peak of s.f.e. does not always occur simultaneously at different locations but it is more retarded with increasing solar zenith distance in the sunlit hemisphere for some weak s.f.e. The two new characteristics of s.f.e., (b) and (c), are interpreted as results of transient increase in the electric conductivity of the lower ionosphere in the sunlit hemisphere caused by an x-ray solar flare. (auth)

7113 ROCKET MEASUREMENTS OF MID-LATITUDE Sq CURRENTS. Davis, T. N.; Stolarik, J. D.; Heppner, J. P. (NASA-Goddard Space Flight Center, Greenbelt, Md.). J. Geomagnet. Geoelec., 18: 183-8(1966).

Rubidium-vapor magnetometers were flown to altitudes near 150 km over Wallops Island, Virginia, in three Nike–Apache rockets. One flight was made at a time when no ionospheric current was expected and none was encountered. The other two flights measured a current sheet with lower edge at 105 km and upper edge at 123 km, with the total current being in agreement with that expected from the ground observations. (auth)

7114 GENERALIZED DYNAMO MECHANISM IN THE UPPER ATMOSPHERE. Maeda, H. (National Center for Atmospheric Research, Boulder). J. Geomagnet. Geoelec., 18: 173-82(1966).

The atmospheric dynamo mechanism associated originally with ionospheric winds is extended to include the effect of the solar wind, being now called a generalized dynamo mechanism. The daily geomagnetic variations are summarized and classified on the basis of this generalized dynamo mechanism, and the method of mathematical formulation of the mechanism is briefly discussed by taking into account the electric linkage between geomagnetic conjugate points and also between the ionosphere and the magnetosphere. (auth)

7115 GEOMAGNETIC DISTURBANCE, PLASMA WIND AND SOLAR ACTIVITY. Sarabhai, V.; Pai, G. L.; Patel, D.; Pathak, P. N. (Physical Research Lab., Ahmedabad, India). J. Geomagnet. Geoelec., 18: 157-61(1966).

The analysis of data for 1960, 1961, and 1962 shows that the daily planetary index of geomagnetic disturbance $K_p \geq 25$ occurs about as often with decreases ($dI/dt < 0$) as with increases ($dI/dt > 0$) of daily mean intensity of galactic cosmic rays measured on the earth. The association of these two types of $K_p \geq 25$ epochs and of International Quiet Days with the central meridian passage of long lasting zones of activity in the corona at the solar equator was studied. It is suggested that high K_p is caused by two distinct types of interplanetary conditions, (a) the passage of a corotating shock front or a radially advancing blast wave, and (b) the emergence of the earth from a cavity as proposed by Sarabhai considering the consequences of nonuniformity of solar wind velocity. The occurrence of an International Quiet Day is related to c.m.p. of the intermediate point of declining intensity on the trailing edge of a bright coronal zone which should produce a cavity (a region of reduced plasma density and weak magnetic field) where slow plasma does not catch up with fast plasma in front of it. (auth)

7116 STUDY OF THE RELIABILITY OF POLAR CAP ABSORPTION AS A PREDICTOR OF GEOMAGNETIC STORMS.

Moe, Kenneth (Univ. of California, Los Angeles). J. Geomagnet. Geoelec., 18: 151-5(1966).

Simulated predictions of geomagnetic storms are made, using polar cap absorptions derived from the IGY ionosonde records for two stations on each polar cap, published by Jelly and Collins. The larger storms are "predicted" 70% of the time, and the smaller storms 40%. This method (using only four stations) is incapable of predicting the size of the storm, although an earlier study using Hill's ionosonde data from 70 stations in the Northern Hemisphere indicated the size of the following storm fairly well. Several other methods of rapidly detecting solar emissions or polar cap absorptions are examined with regard to their utility as predictors of geomagnetic storms. (auth)

7117 ADIABATIC MOTIONS OF CHARGED PARTICLES IN A DIPOLE MODEL OF THE MAGNETOSPHERE. Hones, Edward W. Jr. (Univ. of Iowa, Iowa City). J. Geomagnet. Geoelec., 18: 133-40(1966).

The use of the first and second adiabatic invariants of charged-particle motion in calculating the trajectories of particles drifting in combined magnetic and electric fields is discussed. Such calculations become particularly simple for a dipole magnetic field if the magnetic lines of force are electric equipotentials. (auth)

7118 RELATIONSHIP OF GEOMAGNETIC STORMS TO THE DENSITY OF THE UPPER ATMOSPHERE. Moe, Kenneth (Univ. of California, Los Angeles). J. Geomagnet. Geoelec., 18: 141-50 (1966).

The increase in the temperature and density of the upper atmosphere during geomagnetic storms is discussed. The latitude dependences of various phenomena related to storms are examined in an effort to determine the latitude dependence of the neutral heating, which is not well determined by the drag of satellites. The energy balance in the auroral zone during storms is also discussed. (auth)

7119 EQUATORIAL SPREAD-F AND TROPOSPHERIC TROPICAL DISTURBANCES. Maeda, Kaichi (Goddard Space Flight Center, Greenbelt, Md.); Badillo, Victor L. J. Atmos. Sci., 23: 812-15(Nov. 1966).

Characteristic differences of the spread F in polar and tropic regions are briefly summarized. Information from an analysis of data from tropical stations is included on the occurrence of the equatorial spread F and the effects of tropical tropospheric disturbances on the spread F. Dates and names of the typhoons appearing in the analysis are shown. It is concluded that equatorial spread F is a rather regular nighttime phenomenon, which occurs every day, if the ionospheric F region is not disturbed dynamically as well as geomagnetically; if the ionosphere is extremely quiet, equatorial spread F can occur even in the daytime. (J.H.M.)

7120 INTRUSION OF PLASMA INTO A MODEL MAGNETOSPHERE. Bostick, W. H.; Byfield, H.; Jermakian, A. (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Fluids, 9: 2287-8(Nov. 1966).

Photographic evidence is supplied to support previous probe measurements which indicate that, in the plasma flow over a magnetic dipole, the plasma front breaks up into columnar vortices which line up with the magnetic field. (auth)

7121 LOW-FREQUENCY WHISTLER MODE. Kennel, C. (Avco-Everett Research Lab., Everett, Mass.). Phys. Fluids, 9: 2190-2202(Nov. 1966).

Resonant growth (or damping) of electromagnetic waves propagating at an angle to the magnetic field in a model plasma is assumed to arise from a two-component velocity distribution consisting of a dense, cold-background plasma-propagation medium, and a diffuse energetic nonthermal "tail," responsible for resonant particle effects. The low-frequency whistler mode, $eB/M^+c \ll \omega \ll eB/M^-c$, is treated in detail. When the energetic resonant electrons have a sufficiently hard-energy spectrum, and a pitch angle anisotropy corresponding to more electron energy perpendicular than parallel to the magnetic field, the whistler can be unstable over a significant cone of wave propagation angles to the magnetic field. Detailed computations of this growth rate for various energy and pitch angle distributions are presented as a function of wave normal angle to the field. The unstable cone is small when the high-energy tail is not well populated. For this reason, whistlers are usually thought to be heavily damped in low β ($= 8\pi p/B^2$) plasmas. Whistler instability may limit the intensity of trapped high-energy electrons in the earth's Van Allen belts. (auth)

7122 ADIABATIC INVARIANT TRAPPED RADIATION SHELLS AND COSMIC-RAY CUTOFFS IN MODELS OF THE MAGNETOSPHERE DISTORTED BY THE SOLAR WIND PLASMA. Friedland, Allan Burton. Ithaca, N. Y., Cornell Univ., 1966. 214p.

Thesis.

Ray has found an approximate first integral for the motion of charged particles in static magnetic fields not necessarily displaying axial symmetry. This involves a canonical transformation to a new set of coordinates, one of which is approximately ignorable. In field models which approximately preserve this new kind of symmetry, of which the geomagnetic field is an example, a perturbation technique is here employed to derive an improved version of Ray's first integral. In the technique, conservation of energy, adiabatic invariance of the magnetic moment, Ray's first integral, and the slow drift motion of the particles under consideration are used as the zeroth order solution. The resulting quadrature predicts the splitting of magnetic shells in field models which do not display axial symmetry. This result was first suggested by Stone but is unsatisfactorily described by the McIlwain "L" parameter for models of the earth's field which are severely distorted because of the "solar wind plasma." The improved first integral is further used to derive a new method for calculating cosmic ray cutoffs at the surface of the earth. This method replaces the traditional Stormer theory and its refinements put forward by other authors. (Dissertation Abstr.)

7123 PHYSICS OF THE LOWER IONOSPHERE. Whitten, R. C.; Poppoff, I. G. Englewood Cliffs, N. J., Prentice-Hall Inc., 1965. 237p. $7.95.

Results are presented of current studies in ion kinetics, the interactions between solar disturbances and atmospheric constituents, and such related topics as ionic reactions, ionization processes and atmospheric structure. The discussion on solar radiation considers only those aspects of the field which have a direct bearing on the structure of the ionosphere. Appropriate aspects of aeronomy, atomic physics, and radio propagation are discussed. (J.H.M.)

7124 FLUID DYNAMIC ASPECTS OF SPACE FLIGHT. VOLUME ONE. Proceedings of the AGARD-NATO Specialists' Meeting Sponsored by the Fluid Dynamics Panel of AGARD, Marseille, France, April 20–24, 1964. AGARDograph 87. Volume One. New York, Gordon and Breach Science Publishers, 1966. 411p. (CONF-640419-(Vol.1)).

Various papers are included on the following subject areas; fluid dynamic aspects of weightlessness, rarefied gas effects at near space conditions, effects of space environments on space vehicle components, and particle impact on surfaces at high velocities. (M.O.W.)

7125 INTERPRETATION OF IMPEDANCE PROBE MEASUREMENTS IN THE IONOSPHERE. Grard, Rejean Jules Leon. Stanford, Calif., Stanford Univ., 1966. 95p.

Thesis.

Measurements of the very-low-frequency impedance of the sheath which surrounds a probe in the ionosphere can provide instantaneous and continuous information on the electron density and temperature. A simplified theory of the sheath was developed and its validity was checked in the laboratory. Variations of the sheath impedance with frequency, electron density and probe potential are presented. The ac impedance of a dipole was measured in the innosphere. The interpretation of the data is complicated by the effect of the earth's magnetic field and the wake of the rocket, but the theoretical treatment is shown to apply with reasonable accuracy at low frequency. A discussion is given of the utility of impedance measurements in the ionosphere as a diagnostic technique. (Dissertation Abstr.)

7126 DIRECTIONAL OBSERVATIONS OF AURORAL-ZONE X RAYS AND THEIR RELATIONSHIP TO IONOSPHERIC CURRENT SYSTEMS. Gosling, John Thomas. Berkeley, Calif., Univ. of California, 1965. 85p.

Thesis.

Ten high-altitude balloons carrying scintillation detectors capable of a directional response to auroral-zone x rays (E > 25 keV) were launched from Fairbanks, Alaska, during June and July of 1964. Directional fluxes were detected at various times during six of these balloon flights. Measurements at times of strong geomagnetic bays show that electron precipitation, responsible for the x rays, is localized close to or within the auroral electrojet, and the two phenomena show similar motions. This is in agreement with some auroral observations (1- to 10-keV electrons) during geomagnetic bays, and also substantiates earlier indirect measurements. From this it is clear that electron precipitation is the catalyst that triggers the electrojet. A further result of the flight program is that electron precipitation is generally localized in thin belt-like regions extending in the east–west direction along the auroral zone. (Dissertation Abstr.)

Low-Temperature Physics

Refer also to abstracts 6799 and 6821.

7127 (AD-633685) ELECTRODYNAMICS OF A SUPERCONDUCTING PARALLEL PATH CIRCUIT. Final Report. King, Everett E. (Naval Research Lab., Washington, D. C.). May 9, 1965. 78p. (NRL-6410). CFSTI $3.00 cy, $0.65 mn.

In order to understand better the behavior of superconductors in electrical circuitry, a detailed study is presented of a circuit composed of two superconducting inductances connected in parallel. This circuit forms a closed superconducting path through which the magnetic flux will remain constant only if the resistance of the superconductor is zero. In this regard, an upper limit for the dc resistivity of a superconductor is found by two methods. The first method appears in the literature several times and consists of an attempt to detect the decay of a persistent current. The second method has not been reported previously and consists of an attempt to observe between the two branches a current distribution different from that which conserves the flux linkage. These methods differ in that, in the first method, the persistent current exists entirely within the superconductor; whereas, in the second method, the externally supplied current must both enter and leave the superconductor. The transient response of the circuit is investigated also. The flux linkage is verified to remain constant to within an experimental error of about 1% for current changes as short as about 1 microsecond. (auth)

7128 (AD-637824) DE HAAS-VAN ALPHEN OSCILLATIONS IN THE CRITICAL TEMPERATURE OF TYPE II SUPERCONDUCTORS. Gunther, Leon; Gruenberg, Leonard W. (Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy). Aug. 8, 1966. Contract Nonr-3963(16). 10p. (TR-3). CFSTI $3.00 cy, $0.65 mn.

The report shows that the critical temperature $T_c(H)$ of a type-II superconductor exhibits dHvA oscillations with the usual period μ/ω_c where μ is the Fermi energy and $\omega_c = eH/mc$ is the cyclotron frequency. The result includes electron spin and is valid even outside the Ginzburg-Landau region. It demonstrates the feasibility of observing the effect at low temperatures through the oscillations of the resistivity in the transition region. (auth)

7129 (BNL-9628) THERMODYNAMICS OF "IRREVERSIBLE" SUPERCONDUCTORS: TRAPPED FLUX AS THE LOWEST FREE ENERGY STATE. Schweitzer, Donald G.; Bertman, B. (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

It is shown that a vast quantity of experimental data on what are commonly called irreversible superconductors can be analyzed to show that superconductors containing defects are in their lowest free energy state when they retain flux in the absence of an external magnetic field. (M.H.R.)

7130 (BNL-9629) EQUIVALENCE OF HYSTERESIS AND PHASE EQUILIBRIA: THE THERMODYNAMIC ORIGIN OF HYSTERESIS IN SUPERCONDUCTORS. Schweitzer, Donald G. (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT(30-2)-Gen-16. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The thermodynamic properties of hysteresis loops are described and it is shown that they are also general properties of equilibrium phase systems. In the examples given the major hysteresis loops of "irreversible" superconductors are considered. It is shown that the thermodynamic argument for the stability of trapped flux given in other works (BNL-9628) also accounts for hysteresis. (M.H.R.)

7131 (CERN-66-32) SOME APPLICATIONS OF SUPERCONDUCTIVITY. Klose, W. (European Organization for Nuclear Research, Geneva (Switzerland)). Oct. 19, 1966. 32p. Dep. mn.

The fundamental properties of superconductors are discussed in terms of persistent currents, critical magnetic field, magnetization, critical currents, and intermediate and mixed states. Other topics considered include: thermodynamics of superconductors, electrodynamics of superconductors (London Theory), microwave absorption (Pippard Theory), high-field superconductors, thermodynamics of high-field superconductors (Ginzburg-Landau Theory), and superconducting devices. (W.D.M.)

7132 (TID-23459, pp 1-6) MICROWAVE SPECTROSCOPY. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

The low-temperature ultrasonic reflection coefficients of thin films of tin were studied in order to determine the electronic contribution to the ultrasonic attenuation coefficient at 9 GHz. Details of the ultrasonic energy flow within the film are presented. (M.O.W.)

7133 INTERACTING MIXED SYSTEM OF BOSONS AND FERMIONS AT FINITE TEMPERATURE. I. Savoia, M.; Sawicki, J. (Centro de Investigacion y de Estudios Avanzados, Mexico City). Nuovo Cimento (10), 46A: 484-501(Dec. 1, 1966).

A microscopic theory of the mixed interacting system of bosons and fermions at finite temperatures is discussed. Two models are developed for calculating the single-boson and single-fermion excitation spectra in the mixed system, both based on the hierarchy of the temperature-dependent causal Green's functions. The case of the Bose condensation of the boson phase is considered in detail. Corrections to the Dyson mass operators are derived due to self-interactions through the intermediate of ring diagrams of the fermion particle-hole pairs treated in RPA approximation. The limitations of the models and their connection with some previous models for the boson case are discussed. (auth)

7134 ABRIKOSOV STRUCTURE IN TYPE-II SUPERCONDUCTORS. Peschel, Ingo (Univ., Erlangen-Nuermberg). Solid State Commun., 4: 495-8(Oct. 1966). (In German).

A clean type-II superconductor with two electron bands is investigated. Generalized Ginzburg-Landau equations are used to determine transition temperature, upper critical field, and vorticity solution of the Abrikosov state. (auth)

7135 SECOND-KIND SUPERCONDUCTIVITY OF INDIUM-LEAD ALLOYS. Noto, Koshichi; Muto, Yoshio; Fukuroi, Tadao (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 21: 2122-31(Nov. 1966).

The magnetization curves of In alloys containing 4.39, 4.75, and 5.57 at. % Pb have been obtained as a function of temperature down to 0.38°K. Three critical fields, $H_{c2}(t)$, $H_{c1}(t)$, and $H_c(t)$, have been determined in the reduced temperature range corresponding to $1 > t^2 > 0.01$. Three kinds of Ginzburg-Landau parameters defined by Maki, $\kappa_1(t)$, $\kappa_2(t)$, and $\kappa_3(t)$, agree well with each other at any temperature. The temperature dependence of $\kappa_1(t)$ follows qualitatively Maki's prediction, while those of $\kappa_2(t)$ and $\kappa_3(t)$ do not. The experimental agreement between $\kappa_1(t)$ and $\kappa_2(t)$ can be explained by the recalculation of $\kappa_2(t)$ by Caroli et al. The concentration dependence of $\kappa_1(t)$ is contrary to theoretical results. By analyzing the results, it was found that alloys with more than 4.1 at. % Pb belong to the second-kind superconductor at any temperature and those with 3.5 to 4.1 at. % Pb show the transition from first- to second-kind superconductivity at a certain temperature. The small residual magnetization tails are discussed on the basis of the surface superconductivity. (auth)

7136 MAGNETIC PROPERTIES OF SUPERCONDUCTING Sn FILMS. Ogawa, Soichi; Shigi, Toyoichiro (Osaka City Univ.). J. Phys. Soc. Jap., 21: 2427(Nov. 1966).

Relatively uniform Sn films varying in thickness from 360 to 3050 Å were prepared by vacuum deposition onto substrates at about 80°K. Resistance measurements to determine the critical field and the critical temperature were performed. Curves show the critical field as functions of temperature and film thickness. The slopes of the curves decrease with increasing film thickness and decreasing temperature. It is concluded that the magnetic properties of superconducting Sn films agree very well with the theories for very thin films near the critical temperature but some disagreements occur for thicker films. (A.G.W.)

7137 SUPERCONDUCTING PROPERTIES OF Nb_6Sn_5 AND OF MULTIPHASE Nb-Sn ALLOYS. Enstrom, Ronald E. (RCA Labs., Princeton, N. J.). J. Appl. Phys., 37: 4880-2(Dec. 1966).

The critical temperature of Nb_6Sn_5 is less than 2.8°K and the maximum critical field is less than 600 G at 2.1°K. Since $NbSn_2$ also has a transition temperature below 4.2°K, Nb_3Sn is the only compound in the Nb-Sn system that is superconducting at 4.2°K. Nb_3Sn can be formed at temperatures as low as 600°C, and accounts for the observed high-field superconductivity in multiphase alloys where Nb_6Sn_5 or $NbSn_2$ may be the predominant phases present. (auth)

7138 SUPERCONDUCTING TRANSITION TEMPERATURE OF SOLID-SOLUTION Ta-Ti ALLOYS. Colling, D. A.; Ralls, K. M.; Wulff, J. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 37: 4750-2(Dec. 1966).

The composition dependence of the superconducting transition temperature T_c was measured for the solid-solution range of the system Ta-Ti. T_c values, determined resistively for heavily cold-worked wire specimens, varied smoothly with composition, exhibiting a maximum of 8.8°K corresponding to a valence-electron-to-atom ratio of 4.5. Little sharpening of transitions was found for annealed samples, and lower values of T_c were obtained. The change in T_c of a nominally equiatomic alloy with heat treatments in the range 300° to 1200°C is discussed in terms of the microstructural changes. (auth)

7139 EFFECT OF VANADIUM ON THE STRUCTURE AND SUPERCONDUCTING PROPERTIES OF NIOBIUM-ZIRCONIUM ALLOYS. Savitskii, E. M.; Baron, V. V.; Efimov, Yu. V. Izv. Akad. Nauk SSSR, Metal., No. 3, 156-60(1966). (In Russian).

The effect of vanadium (up to 15%) on the structure, critical

current and the temperature of transition to the superconducting state of binary Nb–Zr alloys was investigated. The alloys were melted from 99.75 to 99.95% pure components in a nonconsumable electrode arc furnace in a helium atmosphere at a pressure of 0.7 atm, homogenized at 1100°C for 200 hr, upset at 900 to 1000°C with reductions of up to 20%, annealed at 900°C for 100 hr, and furnace cooled. In the as-cast condition the majority of the alloys had a single-phase structure of β-solid solution with a bcc lattice. After annealing, only binary Nb–V alloys and ternary Nb-base alloys had a single-phase structure. The majority of annealed alloys contained two phases: the β–Nb-base solid solutions with a bcc lattice and the α–Zr-base solid solutions with a hexagonal lattice. The investigated Zr-rich region of the Nb–Zr–V system contained a three-phase region where a ZrV_2 compound was present in equilibrium with the two solid solutions. Alloying with V slightly decreased the lattice parameters in binary Nb–Zr alloys. The strength of cold-strained alloys with 5% V and of binary Nb–Zr alloys increased from 134 to 185 kg/mm^2 with increasing Zr content from 0 to 50% and then decreased with a further increase in Zr content. Alloys containing more than 70% Zr and 5% V did not sustain cold deformation without process annealing. The temperature of transition to the superconducting state was measured with a special unit. Alloying with V lowered the superconducting characteristics of the binary Nb–Zr alloys. The decrease in the critical current was particularly sharp with small additions of vanadium, while the temperature of the transition to the superconducting state decreased gradually with increasing Zr content. Annealing (at 900°C) increased somewhat the critical current of ternary alloys, but the achieved maximum critical current (18 to 19 amp) was lower than that of cold-strained binary alloys. It appears that binary Nb–Zr alloys have the most favorable conditions for the presence of superconducting properties, and any departure from the optimal conditions, caused by addition of vanadium, lowers the superconducting properties of binary alloys. (ATD)

7140 DIRECT MEASUREMENT BY NUCLEAR MAGNETIC RESONANCE OF THE MAGNETIC FIELD DISTRIBUTION OF A TYPE-II SUPERCONDUCTOR. Delrieu, J. M.; Winter, J. M. (CEN, Saclay, France). Solid State Commun., 4: 545-8(Oct. 1966). (In French).

The nuclear magnetic resonance of ^{93}Nb nuclei in the superconductive state (type-II) near H_{c_2} was observed directly in pure powdered niobium metal as a function of the external magnetic field. Theoretical calculations of line shape and width were made using the assumption of a triangular or square lattice of flux lines in type-II superconductors. The observed line shape and width are in numerical agreement with the calculations for a triangular lattice. The saturation of the line was studied in the situation where the flux line broadening becomes greater than the line width observed in the normal state. (auth)

7141 FORCE-REDUCED SUPERCONDUCTOR TOROID. Boom, R. W.; Nuding, J. M. (Atomics International, Canoga Park, Calif.). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2, 338(Sept. 1966).

A force-reduced toroid was constructed with 0.010-in. Nb–25 at.% Zr. The toroid dimensions are a 12-in. major dia and 0.8-in. minor dia. Each layer is wound at a different pitch angle; the inner turns form a 12-in. hoop while the outer turns are wound conventionally around the 0.8-in. cross section. The winding prescription used is given by the approximate solution for the 2 orthogonal current densities: $j_\phi = \alpha H_\phi = c\alpha J_0(\alpha r)$ and $j_\Theta = \alpha H_\Theta = c\alpha J_1(\alpha r)$, where ϕ and Θ are angles measured around the major and minor circumferences, respectively; J_0 and J_1 are Bessel functions of αr, α is constant, and r is the radius of a winding layer measured from the central strands. The critical current at 4.2°K for the toroid was 62 A as compared to ~30 A for 0.01-in. Nb–Zr in a tightly wound small solenoid. Higher currents for this configuration could be due to the fact that current capacities for superconductors in longitudinal magnetic fields (external field parallel to the transport current) are up to ten times higher than for transverse fields. It is estimated that the wire throughout the toroid is in fields longitudinal to within ±15°. (BBB)

7142 SCATTERING OF SLOW NEUTRONS IN SUPERCONDUCTORS. Ginzburg, S. L.; Maleev, S. V. (Ioffe Inst. of Physics and Technology, Leningrad). Fiz. Tverd. Tela, 8: 2320-5(1966). (In Russian).

The problem of the conduction–electron scattering of slow neutrons in superconductors is examined. It is shown that in a number of cases the scattering cross section can be several times greater than the electron-scattering section in normal metal at the same temperature. Expressions are also derived for polarization of scattered neutrons. Unlike the cross section, polarization with scattering in superconductors differs little from polarization with scattering in normal metals. The neutron–electron scattering cross section is presented. It is emphasized that the detection of the effects in question are at the limit of present-day experimental possibilities; therefore there is no sense in considering the possibilities of a detailed study of the electron spectrum in superconductors by means of neutrons. (TSS)

7143 GUIDANCE OF MAGNETIC FLUXES BY SUPERCONDUCTING SCREENS. Montambaux, Jean (Office National d'Etudes et Recherches Aerospatiales, Chatillon, France). Rech. Aerospatiale, No. 113, 7-13(July-Aug. 1966). (In French).

Data are provided to show that the unique properties of superconductors at very low temperatures permit a magnetic flux to be guided independently of permeability of the medium. After a review of the main properties of superconductors in macroscopic form, the results of an experimental investigation concerning some circuit configurations appropriate for guiding a magnetic flux are presented. The results emphasize the importance of the trapped fluxes in the behavior of the circuits as a function of the order in which the superconducting state and the magnetic field are established. It is shown that the flux-orientating or -guiding systems using superconductors are of value in complementing the usual components employed in electrotechnical equipment. (BBB)

7144 THE 65BT SUPERCONDUCTING ALLOY. Gorina, N. B.; Gruznov, Yu. A.; Kolobanov, V. V.; (and others) (Central Scientific Research Inst. of Ferrous Metallurgy, USSR). Elektrichestvo, No. 10, 82-3(1966). (In Russian).

A new, relatively low-cost Nb–Ti based alloy, designated 65BT, which meets all the major requirements for superconductors, has been developed. Because of its properties it can be used in (1) magnetizing devices, such as superconducting solenoids, for field strengths varying from 20 to 80 kOe, and (2) wires 0.1 to 0.3 mm in diameter and up to 12,000 m long and tapes 5 μ thick. The alloy, which contains 65% niobium, 25% titanium, and several other components, is produced in an arc furnace and, after thermal processing, is cold drawn. For use in superconducting solenoids, the alloy requires a 0.02- to 0.05-mm copper coating. (ATD)

7145 COMPARATIVE EVIDENCE SUGGESTING CLASSICAL BEHAVIOR OF ROTATING LIQUID HELIUM II. Van Atta, C. W. (Univ. of California, San Diego, La Jolla). Phys. Rev., 152: 181-3(Dec. 2, 1966).

Several experimental findings of Pellam concerning the transient motion of liquid helium II contained in a suddenly accelerated or decelerated rotating cylindrical container are found to be consistent with results obtained by McLeod in a rotating classical liquid. It appears unnecessary to appeal to quantum effects to explain the helium II results in question. The velocity-versus-time curves for helium II closely resemble those obtained at the largest Reynolds number in water and exhibit a similar departure from two-dimensional viscous theory. For both liquids, a well-defined rotation front is found to propagate inward from the moving wall upon setting the container into motion. The inherent instability of fluid contained in a suddenly decelerated cylinder appears to be responsible for the apparent rigidity of rotating liquid helium II. (auth)

7146 NEGATIVE-ION CAPTURE BY VORTEX LINES IN HELIUM II. Tanner, D. J. (Univ. of Chicago). Phys. Rev., 152: 121-8(Dec. 2, 1966).

Negative-ion absorption was studied by rotating He II from 0.98°K to 1.7°K. Measurements of vortex-line capture cross sections are reported as a function of temperature (0.98°K to 1.7°K) at three electric fields (16.3, 49.0, and 97.9 V/cm) and as a function of electric field (10 to 200 V/cm) at two temperatures. Great care was taken to ensure that the reported cross-section values were not affected by space-charge effects. The results are found in good agreement with the ion-capture theories developed by Donnelly and Roberts. The decrease in cross section above 1.6°K is in agreement with the escape calculation of Parks and Donnelly and supports their value of 15.96 Å for the negative-ion radius. (auth)

7147 TIME VARIATION OF THE GINZBURG–LANDAU ORDER PARAMETER. Abrahams, Elihu; Tsuneto, Toshihiko (Rutgers Univ., New Brunswick, N. J.). Phys. Rev., 152: 416-32(Dec. 2, 1966).

A nonequilibrium form of the Green's-function formulation of the BCS theory of superconductivity is used to investigate the circumstances under which differential equations in the space and time, i.e., time-dependent Ginzburg–Landau equations, give a valid description of the space and time variation of the order parameter Ψ in superconductors. It is found that if the variations are sufficiently slow, time-dependent Ginzburg–Landau equations exist near absolute zero and near the transition temperature. In the former case the equation has wave-like character, and in the latter case it is of diffusion type, with the restriction that either

the characteristic frequency of the time variation of Ψ is greater than the gap frequency or the ratio of the Fermi velocity to the product of the characteristic wavelength and frequency of the space–time variation of Ψ is greater than unity. Under all other circumstances and at general temperatures, there are no differential equations to describe the variations of Ψ. The influence of slowly varying time-dependent fields is discussed, and the dependence of charge and current densities on the variations of Ψ is derived. Local electrodynamics are assumed. The necessary modifications for the case of dilute superconducting alloys are described. Applications are made to the questions of collective modes, nucleation, and London's theory near absolute zero. (auth)

7148 SUPERCONDUCTIVITY OF THORIUM AND URANIUM. Gordon, J. E. (Amherst Coll., Mass.); Montgomery, H.; Noer, R. J.; Pickett, G. R.; Tobon, R. Phys. Rev., 152: 432-7(Dec. 2, 1966).

The low-temperature susceptibility and specific heat of thorium and uranium have been measured. It is found that thorium becomes a superconductor at $T_c = (1.374 \pm 0.001)°K$, and has a value of $C_{es}(T_c)/\gamma T_c = 2.42$, in good agreement with BCS theory. Here C_{es} is the superconducting electronic specific heat, and γ is the temperature coefficient of the normal electronic specific heat. The γ and Θ_D for thorium were found to be (4.31 ± 0.05) mJ/mole deg^2 and $(163.3 \pm 0.7)°K$, respectively. Both uranium samples appeared to undergo superconducting transitions when observed magnetically, yet both exhibited only normal-state behavior in their specific heat. Hence it seems likely that the apparent superconductivity of alpha uranium is not characteristic of the bulk metal. The γ and Θ_D of the purer uranium sample were found to be (10.03 ± 0.02) mJ/mole deg^2 and $(207 \pm 1)°K$, respectively. (auth)

7149 SUPERCONDUCTING TRANSITION TEMPERATURES AND LATTICE CONSTANTS FOR THE PSEUDOBINARY SYSTEM Nb_3Al–Nb_3Sb. Rothwarf, F. (Frankford Arsenal, Philadelphia); Schmitz, J. A.; Dickson, C. C.; Thiel, R. C.; Boller, H.; Parthe, E. Phys. Rev., 152: 341-4(Dec. 2, 1966).

The $Nb_3Al_{1-x}Sb_x$ system was studied using the Debye–Scherrer method to determine the lattice constants of sintered samples. A complete series of solid solutions having the Cr_3O(A15 or β-tungsten)-type structure was found to exist with lattice constants varying smoothly from 5.183 ± 0.002 Å (Nb_3Al) to 5.263 ± 0.002 Å (Nb_3Sb). The superconducting transition temperatures, T_c, were determined by the sharp change, with temperature, of the self-inductance of a coil into which the samples were placed. Such inductance changes were measured using a sensitive impedance bridge operated at 1 kc/sec. T_c falls parabolically from $T_c(0) = 17.77°K$ for Nb_3Al to $T_c(0.9) = 3.92°K$ for $Nb_3Al_{0.1}Sb_{0.9}$. The relation $T_c(x) = [T_c(0) - T_c(1)](1 - x^2) + T_c(1)$ fits the experimental points closely. The fact that T_c is high for an average ratio of valence electrons to atoms (e/a) of 4.5, and is low for e/a = 5 is consistent with the trend noted in the literature for similar intermetallic compounds having an A_3B composition with non-transition-element B atoms. (auth)

7150 EXPERIMENTAL EVIDENCE FOR A SURFACE MECHANISM FOR HYSTERESIS IN LOW-κ TYPE-II SUPERCONDUCTORS. Schweitzer, Donald G.; Bertman, B. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 152: 293-9(Dec. 2, 1966). (BNL-10115).

The results of several new types of experiments on low-κ type-II hysteretic superconductors are reported. These include measurements of the detailed structure of hysteresis loops, surface-coating experiments, hollow-cylinder magnetization measurements, transport-current measurements, and magnetization of totally hysteretic samples. The results are interpreted in terms of a surface mechanism for hysteresis. (auth)

7151 DENSITY, COEFFICIENT OF THERMAL EXPANSION, AND ENTROPY OF COMPRESSION OF LIQUID ^{4}He UNDER PRESSURE BELOW 1.4 DEG K. Boghosian, Charles; Meyer, Horst (Duke Univ., Durham, N. C.). Phys. Rev., 152: 200-6(Dec. 2, 1966).

The density of liquid ^{4}He at pressures up to 24.5 atm and at temperatures between 0.5 and 1.4°K has been measured by the dielectric-constant method. From the density data the coefficient of thermal expansion, the entropy of compression, and the compressibility as a function of temperature and pressure are derived. The results are discussed in terms of the Landau theory for liquid ^{4}He, and the parameters Δ, μ, and p_0 of the roton excitation spectrum are determined at several pressures and compared with previous determinations. (auth)

7152 LC TIME BEHAVIOR OF WEAK SUPERCONDUCTING LOOPS. Shin, Ernest E. H.; Schwartz, Brian B. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 152: 207-11(Dec. 2, 1966).

Anderson's operator representation is used to obtain the radiative properties of a superconducting loop with a single Josephson junction. The number of displaced pairs, n, and the relative phase across the junction, φ, are treated as canonically conjugate operators. Since n is related to the voltage across the junction by $V = 2en/\hbar$ and φ is related to the current in the loop via the fluxoid quantization, the Hamiltonian for the system, $H = \frac{1}{2}CV^2 + \frac{1}{2}LI^2 - E_J \cos\varphi$, can be reduced to operator form. By applying the Hamiltonian formalism in the usual manner, the equations of motion are obtained. In the limit of small oscillation ($\langle\varphi^2\rangle < 1$), the Hamiltonian can be expanded and yields a solution that corresponds to a resonant frequency $\omega_{LC} = [(1/LC) + (2e)^2E_J/\hbar C]^{1/2}$. This mode corresponds to an LC oscillation of the loop modified by the Josephson junction. For physical situations, the frequency of the oscillation can be adjusted to be as high as 10^{12} sec^{-1}, with a purity of 1 part in 10^5 and at a power output of 10^{-13} W. Under appropriate conditions, in addition to the modified LC resonance, solutions corresponding to the familiar ac Josephson radiation as well as the metastable flux states of a loop with a weak link are obtained. (auth)

7153 HIGH-ENERGY NEUTRON SCATTERING FROM LIQUID ^{4}He. Hohenberg, P. C.; Platzman, P. M. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 152: 198-200 (Dec. 2, 1966).

An experiment is proposed using high-energy neutrons to probe the momentum distribution of helium atoms in liquid helium, and detect the presence of a zero-momentum condensate below T_λ. It is suggested that for momentum transfers to the neutron much larger than a roton momentum, the energy transfer should be equal to the recoil energy of a single helium atom Doppler-shifted by its initial motion in the helium bath. Thus, if a finite fraction of atoms are initially in the zero-momentum state, they will contribute a peak to the spectrum of scattered neutrons. Corrections due to final-state interactions are discussed briefly and estimated. (auth)

7154 EQUILIBRIUM DISTRIBUTION OF RECTILINEAR VORTICES IN A ROTATING CONTAINER. Fetter, Alexander L. (Stanford Univ., Calif.). Phys. Rev., 152: 183-9(Dec. 2, 1966).

A system of rectilinear vortices in an arbitrary multiply connected domain rotating with angular velocity Ω is studied with Lin's general formalism. In the limit of many vortices, the equilibrium distribution is shown to be a uniform vortex density $n = 2\Omega/\kappa$ where κ is the circulation about each vortex. If the inner boundaries are specified by a set of contours C_α, each enclosing an area A_α, then the equilibrium value of the circulation Γ_α about C_α is given by $\Gamma_\alpha = 2\Omega A_\alpha$. In equilibrium, the fluid rotates as a solid body with angular momentum $L = I\Omega$ and energy $E = \frac{1}{2} I\Omega^2$, where I is the moment of inertia. (auth)

7155 FERMION–PHONON INTERACTION: THE ATTENUATION OF SOUND IN A LIQUID ^{3}He–^{4}He SOLUTION. Abraham, B. M.; Eckstein, Y.; Ketterson, J. B.; Vignos, J. H. (Argonne National Lab., Ill.). Phys. Rev. Lett., 17: 1254-6(Dec. 19, 1966).

Sound attenuation measurements are discussed for ^{3}He–^{4}He mixtures near 1°K. Measurements are given for frequencies of 20, 60, 100, and 140 MH_2. (M.O.W.)

7156 MODES OF SOUND PROPAGATION IN DILUTE SOLUTIONS OF ^{3}He IN LIQUID ^{4}He. Eckstein, Shulamith G. (Argonne National Lab., Ill.). Phys. Rev. Lett., 17: 1257-9(Dec. 19, 1966).

The sound propagation in dilute solutions of ^{3}He–^{4}He is investigated at temperatures sufficiently low that the presence of phonons can be neglected. (M.O.W.)

7157 SUPERCONDUCTING TRANSITION TEMPERATURE AND RESISTIVITY OF TIN WHISKERS AS A FUNCTION OF UNIAXIAL TENSION. Davis, J. H.; Skove, M. J.; Stillwell, E. P. (Clemson Univ., S. C.). Solid State Commun., 4: 597-600(Nov. 1966).

The effect of 1% elastic strain on the superconducting transition temperature and resistivity of single crystal tin was measured. In the ⟨100⟩ and ⟨101⟩ directions these quantities are nonlinear in strain. It is suggested that changes in the topology of the Fermi surface cause this nonlinearity. (auth)

7158 EXTREME CURRENTS IN THE SUPERCONDUCTING SURFACE SHEATH. Christiansen, P. Voetmann (Univ., Copenhagen). Solid State Commun., 4: 607-10(Nov. 1966).

The one-dimensional Ginzburg–Landau equation for a superconducting half-space in a parallel magnetic field $H_0 > H_{C2}$ was solved numerically in order to determine the extreme or "critical" currents in the surface sheath. A comparison to earlier calculations shows that the asymmetry of the critical current can be much greater than previously reported. (auth)

7159 HYSTERESIS EFFECTS IN THREE SUPERCONDUCTING PHASES OF GALLIUM. Feder, J.; Kiser, S. R.; Rothwarf, F.; Burger, J. P.; Valette, C. (Centre National de la Recherche

Scientifique, Orsay, France). Solid State Commun., 4: 611-13 (Nov. 1966).

Large superheating and supercooling in the transition of the α and β phases of Ga are observed. A third phase, which is tentatively identified as γ Ga, is found to be superconducting with $T_c = 7.6°K$. (auth)

7160 HIGH-RESOLUTION METHOD FOR INVESTIGATING THE MAGNETIC STRUCTURE OF SUPERCONDUCTORS. Traeuble, H.; Essmann, U. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Technische Hochschule, Stuttgart). Phys. Status Solidi, 18: 813-28(Dec. 1, 1966). (In German).

The magnetic structures of superconducting or ferromagnetic materials can be displayed by the deposition of small ferromagnetic particles formed by evaporation of ferromagnetic materials in a helium atmosphere. The method gives high resolution. Observations can be made using an optical or electron microscope (replica method). The intermediate state of superconducting lead is studied as an example. (auth)

7161 SLOPE FUNCTION OF SUPERCONDUCTING ORIENTED NIOBIUM SINGLE CRYSTALS FROM PROBE MEASUREMENTS. Nembach, E.; Freyhardt, H.; Haasen, P. (Univ., Goettingen, Ger.). Phys. Status Solidi, 18: 807-12(Dec. 1, 1966). (In German).

Measurements are reported of the dislocation density and magnetic hysteresis in the superconducting state as a function of the angle of torsion in (110) oriented 3- and 4-mm-thick niobium single crystals. (auth)

7162 EFFECTIVE MASS OF IONS IN LIQUID HELIUM II. Dahm, Arnold Jay. Minneapolis, Univ. of Minnesota, 1965. 107p.

Thesis.

The effective masses of both positive and negative ions in liquid helium II were determined. Both species of ions were produced by alpha radiation of the liquid. Mobility measurements yield only the ratio of the current relaxation time to the effective mass of either species. By measuring the current relaxation times the effective masses from the known mobilities were determined. The results of the measurements yield an effective mass for the positive ion of 40 ± 20 times the mass of a ^{4}He atom. The effective mass of the negative ion was found to be less than or equal to the effective mass of the positive ion. (TSS)

7163 EXPERIMENTS ON THE VISCOUS FLOW OF HELIUM II BETWEEN ROTATING CYLINDERS. Devaraj, Narasimhaiah. Toronto, Univ. of Toronto, 1964.

Thesis.

Experimental studies were made of the viscous flow of helium II between coaxial rotating cylinders (couette type viscometer), with particular emphasis on the determination of the dependence of the critical velocity v_c, upon the dimensions of the viscometer. The apparatus was constructed with a gap between the cylinders of width (d) of 0.0754 cm and with the length to radius ratio (l/r) of the stationary inner cylinder equal to 3.125. The results obtained at temperatures between 1.515°K and 2.117°K are compared with those of Heikkila and Hallett (1955). (TSS)

7164 SUPERCONDUCTING TRANSITION TEMPERATURES OF AMORPHOUS BISMUTH ALLOY FILMS. Shier, John Shouse. Urbana, Ill., Univ. of Illinois, 1966. 70p.

Thesis.

Measurements have been made of the critical temperatures T_c of amorphous bismuth alloy films containing lead, thallium, and antimony in concentrations up to 13 at. %. The results indicate that the shift in T_c is approximately linear in impurity concentration, as expected. The derivative of T_c with respect to impurity concentration is not simply related to the valence or atomic size of the impurity atoms. It is suggested that this may have the same cause as the breakdown of Linde's rule for liquid alloys. The widths of the transitions of the films into the superconducting state were extremely small (~5 millidegrees). This observation has a direct bearing on our understanding of coherence lengths in superconductors. (Dissertation Abstr.)

7165 THEORY OF ELECTROMAGNETIC PROPERTIES OF STRONG COUPLING AND IMPURE SUPERCONDUCTORS. Nam, Sang Boo. Urbana, Ill., Univ. of Illinois, 1966. 140p.

Thesis.

Using a Green's function formulation, the theory of the electromagnetic properties of superconductors is extended to include the strong coupling case, where the frequency dependence of the gap parameter is taken into account, and to include spin-flip scattering in superconductors containing magnetic impurities. The results reduce to those of Mattis and Bardeen in the appropriate limit. For the strong coupling superconductor Pb, numerical calculations of the conductivity and the surface resistance R_s/R_N have been carried out. It is found that the surface resistance has characteristic peaks (~1.02) near the phonon resonance frequencies (ω_{t1} = 4.4 MeV, ω_l = 8.5 MeV), and has a small dip (~0.95), which is a reflection of the electron–phonon interaction, at frequency $\omega \simeq$ 25 MeV (~ $16\Delta_0$ to $18\Delta_0$), where Δ_0 (= 1.32 MeV) is the BCS energy gap. For a superconductor with magnetic impurities, the density of states, the gap parameter, and the transition temperature are modified; however, they approach the BCS values in the limit $\gamma_s \to 0$ (γ_s is the inverse lifetime due to spin flip scattering of magnetic impurities, that is, proportional to the square of the matrix element for such interactions). It is found that when γ_s is non-zero, there is no singularity in the density of states; further, for values γ_s larger than the gap parameter $\Delta(\gamma_s, T)$, the effective energy gap vanishes, the density of states has a finite value at zero frequency, and the real part of the conductivity ratio σ_1/σ_N has a finite value near zero frequency. This finite value of σ_1/σ_N should lead to infrared absorption at frequencies below the BCS energy gap. For large γ_s, the conductivity approaches that of the normal state. The surface impedance as a function of the frequency is also computed for various values of γ_s and T. The superfluid density $\rho_s(\gamma_s, T/\rho_s(\gamma_s, 0)$, which is inversely proportional to the square of the penetration depth, is found to be smaller than the BCS value (Δ/Δ_0) tanh $(\beta/2)\Delta$ in the local limit. (Dissertation Abstr.)

7166 MEASUREMENTS OF THE VELOCITY OF SOUND IN GASEOUS ^{3}He AND ^{4}He AT LOW TEMPERATURES. Grimsrud, David Theodore. Minneapolis, Univ. of Minnesota, 1965. 91p.

Thesis.

Isothermal measurements of the absolute sound velocity as a function of pressure are reported for gaseous ^{3}He and ^{4}He between 1.2 and 3.8°K. The results were used to calculate the absolute temperature of the liquid helium bath and the second virial coefficient of ^{3}He and ^{4}He in this temperature range. The velocities were measured using a standard low frequency (approximately 2000 cps) closed tube resonator technique. Sound is introduced into the cavity by a miniature hearing aid transducer located at one end of a cylindrical tube. An identical transducer is mounted in a movable reflector at the opposite end and serves as the detector. The distance between successive resonances is one-half wavelength. A measurement of this distance together with the knowledge of the frequency of the wave permits a calculation of the sound velocity. The uncertainty in the velocities measured in this experiment is approximately 0.07%. (TSS)

7167 GROUND STATE OF LIQUID HELIUM–BOSON SOLUTIONS FOR MASS 3 AND 4. Massey, Walter Eugene. Pullman, Wash., Washington Univ., 1966. 204p.

Thesis.

The calculation of the ground state properties of liquid ^{4}He and the calculation of the ground state properties of a mass 3 boson system interacting through the potential appropriate to ^{4}He are considered. The results of the calculations are of intrinsic value and are also useful as a starting point for the calculation of the ground state properties of liquid ^{3}He. An assumed Lennard–Jones 6–12 potential for the interaction between two helium atoms is used to determine the best possible Jastrow type trial wave function to describe the ground state of a ^{4}He system. The actual calculations begin with an assumed form $g(r,\alpha)$ for the pair distribution function. The free parameters α generate a family of possible pair distribution functions. For a given α the expectation value of the kinetic energy is computed by an iteration-variation algorithm based on finding the maximum value of the Wu-Feenberg functional J. The expectation value of the potential energy is given immediately in terms of $g(r,\alpha)$. Thus the expectation value of the Hamiltonian H is found as a function of α. The minimum value of this function in the α space then selects out a best pair distribution function from the $g(r,\alpha)$ family of functions. Using the experimental values of the ground state energy per particle and the equilibrium density for liquid ^{4}He the parameters in the Lennard–Jones 6–12 potential are determined in a self-consistent manner. With the self-consistent potential and the best $g(r,\alpha)$ the ground state properties of the liquid ^{4}He system are calculated. The best $g(r,\alpha)$ is itself one calculated property of the system, others include the energy per particle, the pressure, the compressibility, and the liquid structure function. These are shown as functions of density and are compared with the experimental data for liquid ^{4}He. Using the self-consistently determined potential function the variational calculations are repeated for a mass 3 boson system. The results of this part of the calculation are compared with the experimental properties of liquid ^{3}He and also with the ^{3}He properties as predicted by the modified theory of corresponding states. The comparison in the latter case is valuable because the corresponding states theory predictions can be shown to be applicable to a mass 3 boson system. Approximations used and probable errors in the calculations are discussed in detail. (Dissertation Abstr.)

7168 HIGH FIELD SUPERCONDUCTING MAGNET CONSISTING OF A NIOBIUM–ZIRCONIUM COMPOSITION. Kunzler,

John E.; Matthias, Bernd T. (to Bell Telephone Labs., Inc.). U. S. Patent 3,281,736. Oct. 25, 1966. Filed Apr. 24, 1961.

A superconducting magnet consists of an annular cryostat containing several windings of wire of an Nb–Zr composition ranging from 10% Nb–90% Zr to 90% Nb–10% Zr. Means are provided for introducing a current of such magnitude that the fraction $4\pi ni/10l$ equals at least 30 to 60 kG, where n is the number of turns, i is the current in amperes, and l is the length in centimeters. A suitable technique for preparation of the Nb–Zr material is presented. Data are included on the relationship between critical temperature and composition, between critical current and composition, and between critical current and critical field for given compositions. (A.G.W.)

7169 SUPERCONDUCTING SOLENOID FORMED FROM A NIOBIUM-BASE ALLOY OF VARYING COMPOSITION. Hulm, John K.; Riemersma, Henry (to Westinghouse Electric Corp.). U. S. Patent 3,283,277. Nov. 1, 1966. Filed Nov. 21, 1963.

A solenoid for cryogenic applications is formed from layers of turns of wire of varying Nb–Zr alloy compositions. The central section along the axis of the solenoid is formed of wire having high Zr content, high critical field, and low current density. The intermediate section is formed of Nb–Zr wire of lower Zr content, a wire of still lower Zr content is used for the outermost portion of the solenoid. Substantially better magnetic fields for a given length of a specified superconductor wire can be obtained than would be possible using only an alloy of high Zr content. By varying the diameter of wire used in various sections, further control of the current density in each section can be achieved. (A.G.W.)

Plasma and Thermonuclear Physics

Confinement and Heating of Plasma

7170 (CLM-R-65) ANNULAR PLASMAS PRODUCED BY ROTATING MAGNETIC FIELDS. Davenport, P. A.; Francis, G.; Millar, W.; Taylor, A. F. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Aug. 1966. 26p. Dep. BIS $0.80. HMSO 4s.

A rotating magnetic field was applied to a cylindrical plasma in a discharge tube whose walls were electrically conducting in the azimuthal direction, which imposed the constraint that the net axial magnetic flux in the tube remained constant. A theoretical analysis of the system predicts that the plasma should be confined in an annular configuration, and this was confirmed experimentally by observations using magnetic probes, an image-converter camera and a laser interferometer. A detailed description of the circuits used to pre-ionize the plasma and to produce the rotating field is included. (auth)

7171 (CLM-R-67) BEHAVIOR OF CHARGED PARTICLES IN A TOROIDAL MAGNETIC FIELD. Uo, Koji (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Sept. 1966. 44p. BIS $1.20. HMSO 6s.

The motion of a charged particle in a Tokomak-type magnetic field is analyzed. By using the φ component of the canonical angular momentum in the toroidal coordinate system (r,θ,φ) and the total energy as the constants of motion, the region of allowed particle motion has been calculated. This region is given by a function of the φ-component of the magnetic vector potential A_φ, the vertical magnetic field, the electric field and the initial position and motion of the particle. Then the allowable range of energy and velocity of the particle to be confined within a limiting surface is determined. For given initial position of the particle, the maximum energy of the confined particle shows strong dependence on $\gamma \equiv (v_\varphi)\text{initial}/v$, and strong asymmetry on the sign of γ. The energy and the velocity distributions of the confined particles have strong radial dependence. In the region near the limiting surface, almost unidirection φ motion is allowed for ions. This stems from the fact that the θ component of the magnetic field is the effective agent for single-particle confinement in the toroidal system. The effect of the vertical and radial electric field is discussed. The vertical field is unfavorable for the particle confinement and the radial favorable. (auth)

7172 (NRL-6418) A 5-KJ VACUUM CLAMP SWITCH FOR THE PHAROS 2-MJ CAPACITOR BANK. Young, M. P. (Naval Research Lab., Washington, D. C.). Apr. 4, 1966. 14p.

A 5-kJ vacuum clamp switch has been developed at the Naval Research Laboratory for the Pharos magnetic-compression experiment. Four hundred and twenty of these switches will operate in parallel (at full MJ) as a passive clamp system for the main capacitor bank. The clamp switch is a variation of the Pharos air trigatron starting switch, except that it is housed in a commercial Pyrex tee so that it can be evacuated to one millitorr. The tungsten–copper electrodes with 10-mm gap will hold off the 20-kV bank voltage at this pressure and yet trigger reliably at the low voltage as required. The electrodes, housing, and expansion chamber are assembled with O-ring vacuum seals, allowing rapid interchange or replacement of switch components. The trigger-pin assemblies are identical to those used for the atmospheric-gap starting switches. The clamp-switch terminals, which are an integral part of the electrodes, allow direct mounting across the capacitor high-voltage stud and ground plate. No modification to the existing capacitor bank was required for installation, so the experimental program was not disrupted. Life tests on seven prototype switches showed a reliable life of more than 4000 discharges at 5 kJ per switch. All failures were due to breakage of the Pyrex tee housings. The expected life of all other switch components is many times this. (auth)

7173 (UCRL-50127) NUMERICAL SOLUTION OF MAGNETIC FIELD BOUNDARY-VALUE PROBLEMS. Killeen, John; Rompel, Shirley L. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 1, 1966. Contract W-7405-eng-48. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Fortran program BETA is described. It is suitable for the numerical solution of second-order differential equations of either parabolic or elliptic type in two dimensions. The solution is by finite difference methods using an alternating-direction implicit scheme. Applications to several boundary-value and initial-value problems are given. Particular emphasis is given to solving magnetic field problems in cylindrical coordinates. (auth)

7174 (UCRL-50136) COIL SYSTEM DESIGN FOR A PROPOSED ASTRON DEVICE. Beal, Jack W. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 15, 1966. Contract W-7405-eng-48. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The trapping field in Astron is provided primarily by a long solenoid formed of a series of separate short, ringlike coils aligned end to end. Two different coil systems are compared that could be used in such a solenoid for the Astron. One system has 4-in.-long coils spaced 8 in. between centers (called the 8-in. system), the other has 6-in.-long coils spaced 12 in. between centers (called the 12-in. system). The 12-in. system is found to be somewhat more sensitive to errors in coil alignment, dimensions, and current. The 12-in. system performs adequately, however, and has certain advantages over the 8-in. system in compatibility with existing equipment. In a related study of error fields produced by leads and crossovers to the coils, a coil constructed of two layers of windings was found to produce less error field than one constructed of four layers. (auth)

7175 (AEC-tr-6760) PLASMA PHYSICS AND CONTROLLED NUCLEAR FUSION RESEARCH. Translation of Russian Papers from the Proceedings of a Conference Sponsored by the International Atomic Energy Agency held in Culham, England, September 6–10, 1965. 611p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Included are translations of 34 papers discussing various aspects of thermonuclear research. (M.O.W.)

7176 (ORNL-tr-1438) EXPERIMENTS FOR INCREASING THE PLASMA ARC TEMPERATURE BY REDUCTION OF THE THERMAL CONDUCTIVITY IN A MAGNETIC FIELD. Mahn, C.; Ringler, H.; Wienecke, R.; Witkowski, S.; Zankl, G. Translated for Oak Ridge National Lab., Tenn., from Z. Naturforsch., 19A: 1202-7(1964). 15p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Currently, in different types of high-pressure arc the maximum temperature is limited by radial heat conduction. Heat conduction can be reduced by a magnetic field parallel to the axis of the arc. An experiment is described in which arc temperatures in the region of 10^5°K have been reached. Typical conditions for the discharge in hydrogen are: current = 2000 A, magnetic field = 10 kG, power input = 4 kW per cm arc length, pressure inside the arc = 0.1 atmosphere. A similar experiment was made with helium. (auth)

7177 ON THE ADIABATIC MOTION OF A CHARGED PARTICLE IN THE QUASI-STATIC MAGNETIC FIELD OF A SOLENOID. Seymour, P. W. (Univ. of Adelaide). Austral. J. Phys., 19: 735-46(Dec. 1966).

Following an alternative phase–amplitude derivation of the general forms of r and θ, obtained earlier by Seymour, Leipnik, and Nicholson (SLN) for the motion of a charged particle in the time-dependent magnetic field within a long solenoid, the guiding-center form of the SLN result for r is obtained in the adiabatic limit and is used as a guide to analysis of the charged particle motion when the solenoid magnetic field is quasi-static. This leads to identification of the associated adiabatic invariants, and the analysis then closes with a quantitative examination of the adiabatic

approximation, which sheds interesting light on the required conditions for its self-consistency. (auth)

7178 INVESTIGATION OF HIGH-β PLASMAS IN TOROIDAL MAGNETIC FIELDS. Remy, E. (Institut fuer Plasmaphysik, Munich). Z. Naturforsch., 21a: 1090-7(July 1966). (In German).

Great advances have been made in recent years in the production of dense hot plasmas with the linear theta pinch devices. The confinement time, however, remains limited to several microseconds since in the linear devices the plasma can escape along the field lines at the end of the coil. Investigations on toroidal theta pinches were, therefore, carried out, and these are summarized. In pure circular toroidal magnetic fields if the plasma drifts in the direction of increasing radius of the torus, the plasma is not in equilibrium. With two special toroidal field configurations, the M + S and the toroidal theta pinch with superposed hexapole field, an equilibrium can be experimentally approximated or attained. The M + S configuration belongs to the class of closed configurations, in which the stability question was especially investigated. The toroidal theta pinch with superposed hexapole belongs to the class of open configurations. It shows, in agreement with theoretical expectations, a stable behavior. The cusp loss at the open place of this configuration was experimentally determined and compared with the losses resulting from different models. The theoretical predictions leave a latitude for a loss rate of two orders of magnitude. The present experimental results point to the theoretically most favorable possibilities. (tr-auth)

7179 PLASMA CONFINEMENT IN AN ALTERNATING-CURRENT POLYHEDRIC SYSTEM. Keller, R.; Jones, I. R. (Fonds National Suisse de la Recherche Scientifique, Lausanne, Switzerland). Z. Naturforsch., 21a: 1085-9(July 1966). (In French).

A plasma confined by a polyhedric configuration is explored by means of a piezoelectric probe and photographed with an electronic camera. The configuration of the field is formed by two systems of conductors, one octahedric and the other truncated cubic, fed by high-frequency currents, 90° out of phase with each other. The ensemble behaves as a cusp having a large number of leak points distributed on a sphere. A converging spherical wave was observed. The yield of energy transfer to the plasma is high. (tr-auth)

7180 CROSS-FIELD DIFFUSION OF QUIESCENT POTASSIUM MAGNETOPLASMAS. Wolf, N. S.; Rogers, K. C. (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Fluids, 9: 2294-5(Nov. 1966).

Plasma loss in a single-ended Q device was measured as a function of magnetic field strength by a technique giving $D_\perp$ directly. When fluctuations in the plasma are small compared to kT, $D_\perp$ agrees with the classical result. (auth)

7181 AXISYMMETRIC MINIMUM AVERAGE B CONFIGURATION OF A TRIPLY CONNECTED SYSTEM. Yoshikawa, S.; Christensen, U. R. (Princeton Univ., N. J.). Phys. Fluids, 9: 2295-6(Nov. 1966). (MATT-455).

An axially symmetric toroidal device with one floating conductor which has both minimum average B and high-shear properties is described. Both magnetic well and shear can approach the theoretical maximum in this device. (auth)

7182 ELECTRON AND ION TRANSPORT ACROSS A MAGNETIC FIELD IN AN ARC DIFFUSION EXPERIMENT. Schwirzke, Fred (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 9: 2250-3(Nov. 1966).

The effective ion-diffusion coefficient can be determined from the radial density profile, which in a plasma of finite length is given by the ion transport across and unhindered ion losses along the magnetic field to the conducting end walls. In addition, the electron-diffusion coefficient can be determined from the electron-temperature profile, which depends on the diffusion rate of electrons across the magnetic field, energy dissipation by collisions, and particle losses to the end walls. The measured electron-temperature profile is considerably flatter than expected from collisional diffusion and agrees with the one calculated for Bohm diffusion. The electron-temperature gradient causes a radial electric field which contributes to the ion transport across the field. Taking the ion mobility term into consideration, it is possible to explain the apparent large ion-diffusion coefficients in previous arc diffusion experiments, which were deduced by neglecting electron-temperature gradients and radial electric fields. (auth)

7183 PLASMA EXPANSION IN A MAGNETIC FIELD. O'Neil, Thomas; Fowler, T. K. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 9: 2219-23 (Nov. 1966).

The expansion of a hot plasma in a magnetic field is treated. A background atmosphere may be present, but in examples emphasized the atmospheric pressure is low enough so that its influence is less than that of the magnetic field. The calculation begins after an initial collisional phase, during which free expansion transforms most of the energy into outward radial motion. It is demonstrated by means of a modified virial theorem that this initial outward momentum then dominates the dynamics until expansion is first halted by the field. Though allowed by the theorem, complications such as shock formation, plasma instability, and sweeping up an atmospheric mass comparable to that of the plasma have limited effect. A lower bound on the plasma radius is derived as a function of time which compares well with simple models neglecting these complications. (auth)

7184 ENERGY LOSS IN MOTION OF CHARGED PARTICLE IN WEAKLY TURBULENT MAGNETIZED PLASMA. Tavdgiridze, T. L.; Tsintsadze, N. L. Zh. Tekh. Fiz., 36: 1155-62(July 1966). (In Russian).

The energy loss of a fast charged particle moving through a weakly turbulent plasma in a constant magnetic field is discussed for the case of high particle velocity as compared to the phase velocity of longitudinal (Langmuir) waves. A general expression is derived for the energy lost by the charged particle in scattering Langmuir waves. This rather involved expression is discussed briefly for the case that the Larmor frequency is approximately equal to the Langmuir frequency, and simple expressions for the energy losses in the limiting cases that the Larmor frequency is much higher or much lower than the Langmuir frequency are derived and tabulated. In these limiting cases there are two types of longitudinal waves with greatly differing frequencies; the expressions for the energy losses are tabulated separately for the four possible cases of scattering of a high- or low-frequency Langmuir wave into a high- or low-frequency wave. The most significant losses occur when the ratio of the Larmor to the Langmuir frequencies is high; in this case the loss is proportional to the square of the Larmor to Langmuir frequency ratio. When the Langmuir to Larmor frequency ratio is high the losses associated with scattering of low frequency longitudinal waves into high frequency ones are also high, and are proportional to the fourth power of the Langmuir to Larmor frequency ratio. (ATD)

Diagnostics of Plasma

Refer also to abstracts 7208, 7210, 7274, 7278, and 7286.

7185 (AD-633646) APPLICATION OF A DIFFERENTIAL INTERFEROMETER TO AN AXIALLY SYMMETRIC ARC HEATED PLASMA. Lamb, Jimmy D. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Mar. 1966. 142p. (GSP/PH-66-11). CFSTI $3.00 cy, $0.65 mn.

Thesis.

The refractive index of an atmospheric argon arc-heated plasma was measured with nearly monochromatic 5463 A light. The measurement was made with a differential interferometer which was compact and easy to set up and use. The basic components of the interferometer are two Wollaston prisms and a concave mirror. One prism separates plane polarized light into two diverging components to provide an optical path separation through the test object space. Optical inhomogeneities in the (plasma) object result in phase shifts between the separated rays. These phase shifts are doubled during the return passage of the rays upon reflection by the concave mirror. A second Wollaston prism, analyzer, and camera lens, produce an interference fringe pattern which can be photographically recorded. The plasma-induced phase shifts produce deflections of the nominally straight and parallel fringes. These deflections are proportional to the first derivative of the optical path through the plasma. Integration of the deflection curves was performed to yield the optical path shifts relative to air as a function of lateral distance. (TAB)

7186 (AD-633703) LASER PHASOGRAPHY OF JETS, SHOCKS, AND PLASMAS. Presby, Herman M. (Yeshiva Univ., New York. Belfer Graduate School of Science). Apr. 1, 1966. Contract AF 19(628)-2399. 114p. (AFCRL-66-299). CFSTI $3.00 cy, $0.65 mn.

The phase-contrast microscope of Zernike may be scaled in size and combined with "giant pulse" ruby-laser illumination to make possible the observation of macroscopic moving tenuous objects, such as jets, shock waves, and plasmas. The resulting instrument, referred to as the Laser Phase Macroscope (LPM), has performance similar to that of an optical interferometer operated in the single-fringe mode. The operation of the phase macroscope is treated theoretically, first heuristically and then by diffraction integrals. Conditions for optimum imaging are derived. The "phase plate" of Zernike is modified for use with focused laser illumination, and parameters for optimum imaging are given. Quite different mirrors are required for the full range of interesting plasmas accessible to the LPM. The experi-

mental model is described. Phasograms of weak and strong shocks in air and argon down to 0.5 mm Hg pressure are shown. Rayleigh–Taylor instability behind the shock is observed. Gas jets of various refractivities are also used as test objects. Phasograms of vacuum sparks producing jets of ablated electrode material are shown. Many objects studied are invisible to schlieren photography using the same illumination and optics. (auth)

7187 (AD-638025) THE APPLICATION OF A LANGMUIR TYPE PROBE AND MICROWAVE DIAGNOSTIC TECHNIQUE TO TRANSIENT IONIZED FLOWS. Lederman, Samuel; Wilson, Daniel S.; Dawson, Edward F. (Polytechnic Inst. of Brooklyn, N. Y. Dept. of Aerospace Engineering and Applied Mechanics). Aug. 1966. Contract Nonr-839(38). 147p. (PIBAL-992). CFSTI $3.00 cy, $0.65 mn.

Electron number densities were measured behind the incident shock wave in a pressure-driven shock tube by a microwave resonant-cavity technique and by electrostatic probes. The driven gas was air at initial pressures of 0.5 and 1 mm Hg, and the shock Mach number was varied from 7 to 10. Electron–neutral collision frequency was also determined by the microwave technique. The experimental measurements were compared with other measurements and with theory. (auth)

7188 (CEA-R-3057) EFFET D'UN CHAMP MAGNETIQUE UNIFORME SUR LES PROFILS DES RAIES DE L'HYDROGENE. (The Effect of an Homogeneous Magnetic Field on the Line Profiles of Hydrogen). Nguyen-Hoe; Drawin, Hans-Werner; Herman, Louis (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Aug. 1966. 70p. (In French). (EUR-2972.f). Dep. mn.

The profiles of the hydrogen lines have been calculated taking into account the intermolecular electric field, the electronic collisions, and an external homogeneous magnetic field in which the plasma is imbedded. Electron densities N within the range $10^{15} \leq N \leq 10^{18}$ cm^{-3} and magnetic field strengths $\leq 1.2 \times 10^5$ gauss are considered. These values cover most of the experimental conditions in which one is interested in the present state of research. Numerical results are presented for the lines Ly-α, Ly-β and H-α. For very small magnetic fields the calculated line profiles coincide with the pure Stark profiles recently calculated by Griem, Kolb and Shen. With increasing magnetic fields, important deviations appear. The essential parameters for these deviations are: firstly, the direction of observation with regard to the direction of the magnetic field; and secondly, the ratio between Zeeman splitting in a magnetic field only and the Stark splitting due to the mean intermolecular electric field. Experimental line profiles have been obtained using a linear discharge tube surrounded by an induction coil. The comparison of the theoretical profiles with the experimental ones shows a satisfying agreement. (auth)

7189 (NASA-TN-D-3737) REMARKS ON PRACTICAL SPECTROSCOPIC TEMPERATURE MEASUREMENTS IN PLASMAS. Oertel, G. K. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Dec. 1966. 14p. CFSTI $3.00 cy, $0.65 mn.

Spectroscopic techniques for the determination of plasma parameters are being applied to many laboratory plasmas. An attempt is made to show that the lack of spatial resolution can lead to drastic errors in spectroscopically determined temperatures even in uniform plasmas with thin boundary layers. Although the need for such resolution is emphasized, certain semiquantitative conclusions can be drawn from spatially unresolved spectra. (auth)

7190 (NASA-TN-D-3761) MEASUREMENT OF ION AND ELECTRON DENSITIES OF ELECTRON-BOMBARDMENT ION-THRUSTOR BEAM. Cooper, Dale W.; Kuhns, Perry W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec. 1966. 17p. CFSTI $3.00 cy, $0.65 mn.

Measurements in both the transverse and the longitudinal directions were taken of an ion-thrustor beam with Langmuir and current probes. These measurements resulted in transverse and longitudinal profiles of electron and ion densities. A comparison was made at the beam centerline between Langmuir-probe, current-probe, and microwave-interferometer measurements. The measurements agreed to within ±10%. (auth)

7191 DIELECTRIC RESONANCE PROBES AND DOUBLE PROBES COMPARED. Smith, F. H. C.; Johnston, T. W. (RCA Victor Research Labs., Montreal, Can.). J. Appl. Phys., 37: 4997-8(Dec. 1966).

Measurements of plasma density are reported using electrostatic double probes and dielectric resonance probes. The results show excellent agreement. (M.O.W.)

7192 THEORY OF A PLASMA RESONANCE PROBE IN A MAGNETIC FIELD. Wait, James R. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Appl. Phys., 37: 4905-7(Dec. 1966).

An analysis of the spherical probe immersed in a magnetoplasma is presented. A quasistatic theory is used and the electron plasma is assumed to be homogeneous, cold, and lossless. The sheath is idealized as a concentric vacuum layer of constant thickness. By using a special coordinate transformation, it is shown that the condition for probe resonance may be written in uncoupled form. A particularly simple result is obtained for the lowest-order symmetric mode for small sheath thickness. (auth)

7193 CONTINUUM THEORY OF ELECTROSTATIC PROBES. Su, C. H.; Kiel, R. E. (Bell Telephone Labs., Inc., Whippany, N. J.). J. Appl. Phys., 37: 4907-10(Dec. 1966).

Electrostatic probes of general ellipsoidal configurations are analyzed from a continuum viewpoint for the conditions of a quiescent slightly ionized plasma. Approximate analytic current–voltage characteristics are obtained for arbitrary ellipsoidal shapes. The cylindrical probe and circular disk probe are discussed in detail as two special cases. (auth)

7194 DETERMINATION OF THE GAS TEMPERATURE IN THE AFTERGLOW OF PULSED DISCHARGES BY MICROWAVE PROBING OF STANDING ACOUSTIC WAVES. Born, Gunthard K.; Buser, Rudolf G. (Inst. for Exploratory Research, U. S. Army Electronics Command, Fort Monmouth, N. J.). J. Appl. Phys., 37: 4918-24(Dec. 1966).

The time-varying gas temperature of afterglow plasmas is determined from the frequencies of standing acoustic waves which are produced during the breakdown of low-pressure gases (0.1 to 20 torr). The sound field is probed with free-space microwave (9 and 70 Gc) interferometers in transmission and reflection. Capacitor discharges are found to heat the gas significantly. The temperature does not decay to room temperature within the observed afterglow periods. (auth)

7195 NEW METHOD FOR DETERMINATION OF THE PLASMA POTENTIAL BY A TWIN PROBE. Dote, Toshihiko; Ichimiya, Torao; Takeuchi, Muneaki; Yabuuchi, Seizo (Inst. of Physical and Chemical Research, Saitama, Japan). J. Phys. Soc. Jap., 21: 2426(Nov. 1966).

The proposed method for measuring the space potential of a plasma is based on the spatial distribution of charged particles within the sheath around the probe. In the neighborhood of one probe, called a reference probe, another probe of very small size, called a sounding probe, is put and the current flowing to the sounding probe at a constant potential is measured as the function of the biased voltage of the reference probe. The voltage of the reference probe where the current of the sounding probe becomes maximum is considered to be the space potential. (A.G.W.)

7196 TRANSIENT REFLECTED SIGNALS FROM AN ANISOTROPIC PLASMA. Case, C. T.; Haskell, R. E. (Air Force Cambridge Research Labs., Bedford, Mass.). IEEE (Inst. Elec. Electron. Eng.). Trans. Antennas Propagation, AP-14: 802-3(Nov. 1966).

Transient reflected signals from plasma can be used as a diagnostic tool, in particular, reflected nanosecond pulses to measure the plasma frequency and the cyclotron frequency in an ionized gas confined in a coaxial waveguide with a static magnetic field present. For transient reflected signals from a polarization sensitive medium there is, in addition to characteristic oscillations at the natural frequencies, a marked effect on the instantaneous polarization of the pulse. The case of a very short pulse reflected from a semi-infinite anisotropic plasma was considered. The incident pulse is linearly polarized along the axis and propagation is in the direction of the magnetic field which is along the x_1 axis and propagation is in the direction of the magnetic field which is along the x_3 axis. The reflected pulse then travels in the negative x_3 direction. Two limiting cases are discussed which allow analysis of the transient polarization as the superposition of right and left circular components of the electric field. Curves were obtained which display the transient polarization behavior of the reflected electric field. The instantaneous polarization curves were sensitive to the parameter a, which is one-half the ratio of the cyclotron frequency to the plasma frequency. The time for each lobe of the polarization curve to be traced gives information about the plasma frequency, since the time scale is normalized to the angular plasma frequency. Thus the transient reflected polarized signals may be used as a diagnostic tool in magnetoplasmas. (BBB)

7197 PROPERTIES OF CYLINDRICAL WAVEGUIDES CONTAINING ISOTROPIC AND ANISOTROPIC MEDIA. Clarricoats, P. J. B. (Univ. of Leeds, Eng.); Chambers, D. E. Proc. IEE (Inst. Elec. Eng.) (London), 110: 2163-73(Dec. 1963).

Cylindrical waveguides containing axial metallic, dielectric, ferrite, or plasma rods are widely used both in microwave devices and in experiments to determine the fundamental properties

of materials and ionized gases, so that a knowledge of the propagation characteristics of such structures is important. Cutoff conditions in circular waveguide containing an axial circular rod are considered when the rod is perfectly conducting and is surrounded by dielectric material, also when the rod and the surroundings are comprised of dielectric material, ferrimagnetic material, or plasma. The characteristic equations involve certain cylindrical functions which depend on 2 variables. Contours of these functions are presented for cases corresponding to modes with zero and unit azimuthal dependence. Comparison is made between the cutoff conditions for the above media, and certain relations between these conditions and the behavior under propagating conditions are discussed. For modes possessing zero azimuth dependence, the characteristic equation can be solved under propagating conditions using the contour graphs. As an illustration of the method, results are presented for a cylindrical waveguide containing an unmagnetized plasma rod. (BBB)

7198 KINETIC THEORY OF A SPHERICAL ELECTROSTATIC PROBE IN A STATIONARY PLASMA. Chou, Y. S.; Talbot, L.; Willis, D. R. (Univ. of California, Berkeley). Phys. Fluids, 9: 2150-67(Nov. 1966).

The spherical electrostatic probe in a weakly ionized gas is analyzed on the basis of kinetic theory using a Krook-type model for the collision integral. The charged particle motions are analyzed in energy–angular momentum phase space, and formal integral solutions for the distribution functions are obtained. Moment equations based on the Lees method are derived, taking into account curvature of the particle paths, and sample solutions of these equations are presented. The results obtained agree well with the numerical analysis of Laframboise, in the collisionless limit. It is found that the effect of charged–neutral particle collisions is to extend the probe sheath farther into the plasma and reduce the electron and ion currents, as well as the departures from neutrality within the sheath. Fair agreement is obtained with a moment method based on straight-line trajectories for the charged particles. The continuum limit is not included in the computations. (auth)

7199 PLASMA CONDUCTIVITY AND TEMPERATURE IN A THETA PINCH. Harris, Robert W.; McClintock, J. E. (Sandia Lab., Albuquerque, N. Mex.). Phys. Fluids, 9: 2274-81(Nov. 1966).

Using a new balanced magnetic probe technique the plasma magnetic field in a theta pinch was measured independently of the drive field. The measurements allow a determination of the total plasma current versus time and the plasma current radius versus time. The current radius determined in this manner agrees well with the visible sheath radius from streak photographs. The measurements also allow determination of the plasma conductivity in the sheath, as well as the leakage of trapped flux through the sheath. Temperatures were calculated from the conductivity, using the "weak field" and "strong field" conductivity expressions. An independent spectroscopic temperature measurement for the same plasma is consistent with the "weak field" conductivity expression. Finally, it is shown that the apparent validity of the "weak field" expression is consistent with the average magnetic field strength within the sheath. (auth)

7200 SPECTROSCOPIC INVESTIGATION OF THE PLASMA IN A CONICAL-ELECTRODE SHOCK TUBE. Grechikhin, L. I.; Min'ko, L. Ya.; Nagornaya, N. I. Zh. Tekh. Fiz., 36: 1207-10 (July 1966). (In Russian).

The plasmas discussed earlier were investigated spectroscopically in the range from 3800 to 7000 Å. Time-integrated spectra were recorded of the light from the discharge chamber, the central region of the drift tube, and the reflection zone. These spectra showed that the plasmas had the same composition in all three regions and arose mainly from erosion of electrode and insulation materials in the discharge chamber. Electron densities were derived from the spectra in three different ways: from the depression of the Balmer series limit; from the linear Stark broadening of Hβ, and from the quadratic Stark broadening of CII 4267 Å. When two of the techniques were simultaneously applicable they gave concordant results. The charged particle densities were slightly higher in the reflection zone than in the discharge chamber, and were lower by a factor of 2 or 3 in the drift tube some 15 cm from the discharge chamber. Time resolved spectra were obtained of the radiation from the discharge chamber. These showed that in a typical case (4-kV discharge of a 1950-μF capacitor in 0.07-mm Hg of air) the charged particle density rose from a value of 5.9×10^{17} cm^{-3} at the beginning of the first half cycle to a maximum of 9.0×10^{17} cm^{-3}, and fell to 5.9×10^{17} cm^{-3} at the end of the first half cycle. (ATD)

7201 RADIAL DENSITY AND TEMPERATURE PROFILES AT THE ION CYCLOTRON WAVE RESONANCE POINT. Krawec, Roman (Lewis Research Center, Cleveland). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 4: 2166-70(Dec. 1966).

A simplified theory for an electrostatic probe in a magnetically confined plasma is presented. Interpretations of probe results using the model are compared with those calculated from Langmuir probe theory. The model presented provides an expression for calculating ion temperature from the probe data. Radial profiles of electron density, radial electric field, electron temperature, and ion temperature are presented for two experiments: (1) a dc hot-cathode low-pressure (2μ) discharge confined by a steady magnetic field, and (2) a plasma heating experiment where ion cyclotron waves propagate along the plasma column. The radial electron density profiles show that the maximum density does not occur on axis but at radii of 0.5 to 1.0 cm (the plasma radius was approximately 2.5 cm). The average densities are found to be in agreement with microwave interferometer measurements and consistent with the location of maximum power transfer. The ion and electron temperatures are found to reach a maximum near the plasma boundary. The addition of rf power heats both the ions and electrons, but has little effect on the density. (auth)

7202 COMPARISON OF NUMERICAL CALCULATIONS AND MEASURED SPACE-TIME RESOLVED PLASMA PROPERTIES OF A DYNAMICAL THETA PINCH. Friedrich, Otto M. Jr.; Dougal, Arwin A. (Univ. of Texas, Austin). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 4: 2159-65(Dec. 1966).

A relatively dense, high-temperature, and very dynamic plasma column is produced in a 30-kJ theta pinch. The two-fluid hydromagnetic model programmed in Lagrangian coordinates is used to calculate numerically the electron density, magnetic field, electron temperature, and ion temperature as functions of radial position and time. For an initial density of 5×10^{15} cm^{-3}, computations show that a plasma annulus forms near the cylindrical tube wall, implodes at 10^7 cm/sec, and then oscillates at 10 to 20 Mc. The frequency of these radial oscillations increases, and they are damped as the compression field builds up. With forward bias, maximum ion temperatures are only 300 to 500 eV and electron temperatures are 300 to 600 eV. Maximum ion temperatures as large as 3 keV and electron temperatures of 1.5 keV result when reverse bias is employed. As the initial density is decreased from 1×10^{16} to 2×10^{15} cm^{-3}, the maximum ion and electron temperatures, during the first quarter cycle of compression, increase. Experimental space–time resolved electron densities of up to 10^{17} cm^{-3} obtained employing an infrared maser-excited coupled resonator system, magnetic fields determined from the Faraday rotation of the maser beam, and electron and ion temperatures estimated from x-ray and neutron measurements compare favorably with calculated values. (auth)

7203 MICROWAVE INVESTIGATION OF PLASMAS PRODUCED IN A NUCLEAR REACTOR. Bhattacharya, Ashok Kumar. Urbana, Ill., Univ. of Illinois, 1966. 193p.

Thesis.

Experimental results of microwave investigation of gaseous plasmas produced in the core of a nuclear reactor are reported. The ionization of the gases used—air, the noble gases, and their mixtures—is produced by the nuclear radiation field dependent upon the reactor operating power level. It is shown that the microwave propagation techniques are capable of measuring the reactor power, the local gamma flux and the dynamic reactor response over a wide range of power levels. The technique is virtually unlimited in its ability to follow fast transients in the reactor power. It was used to measure the reactor from 40 kW to 560 MW. The technique was also used to measure the spatial gamma flux profiles in the core of TRIGA MARK II reactor. It can measure both high (>10^{10} r/hr) and low (~10^4 r/hr) gamma dose rate. It is shown that the plasmas thus formed are quite suitable and possibly unique for investigating basic plasma phenomena such as various collision cross sections and electron loss processes. Some of the basic parameters of the plasma, such as the electron temperature, the electron collision frequency for momentum transfer, electron–ion recombination rate were measured. The values thus determined are in agreement with those obtained by others under different conditions. (Dissertation Abstr.)

Kinetics of Plasma

Refer also to abstracts 7049, 7060, 7121, and 7289.

7204 (AD-631047) RESEARCH ON PROPAGATION OF HIGH POWER WAVES IN IONIZED MEDIA. Final Scientific Report. Rydbeck, O. E. H. (Chalmers Tekniska Hogskola, Goteborg (Sweden). Forskningslaboratorium for Elektronik). June 1965. Contract AF 61(052)-451. 10p. (AFCRL-66-128). CFSTI $1.10 cy, $0.50 mn.

Brief summaries are presented for each of the following research areas: extension of nonlinear magneto-ionic theory to diverging waves and application to topside sounder ionograms, periodic coupling between magneto-ionic modes, self oscillations of the pumped ionized medium, Oseen's extinction theorem, nonlinear magneto-ionic wave propagation, linear wave propagation in a double hump barrier, and properties of coupled magneto-ionic equations. (M.O.W.)

7205 (AD–633974) STUDY OF PLASMA TURBULENCE. Final Report, April 24, 1962–September 19, 1965. Drummond, W. E.; Malmberg, J. H. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). May 1966. Contracts AF 29(601)-5338; AF 29(601)-6366. 248p. (AFWL-TR-65-190). CFSTI $3.00 cy, $0.65 mn.

Results are summarized of experimental and theoretical research to investigate turbulence in collisionless plasmas. The quasi-linear theory of plasma turbulence is extended to include the effect of resonant and non-resonant mode-coupling terms. The theory, originally done in the time domain, is applied to the case of spatially growing waves. The generation of electromagnetic radiation at twice the plasma frequency and microwave scattering from plasma turbulence and investigated theoretically. The kinetic theory of unstable plasmas is systematically developed. A measurement of the Landau damping of electrostatic plasma waves is described. The results agree in detail with the predictions of the theory. The growth of unstable plasma waves due to a gentle bump on the velocity distribution function is measured. The termination of the growth, due to nonlinear effects, (i.e., the diffusion of particles in the velocity distribution function by the electric fields of the wave) is observed. These results are also in quantitative agreement with the theory. The full text of eighteen scientific papers resulting from this research program is included. (auth)

7206 (AD–634023) RESEARCH ON UNSTABLE OSCILLATIONS IN ENERGETIC ARCS. Final Technical Report, March 1, 1965–April 30, 1966. Kretschmer, Carl B. (Aerojet-General Nucleonics, San Ramon, Calif.). May 27, 1966. Contract AF 49(638)-1548. 49p. (AN–1512; AFOSR–66-0890). CFSTI $3.00 cy, $0.65 mn.

Gas-fed hollow-cathode vacuum arcs in argon, nitrogen, hydrogen, and helium were studied. These arcs operate in a magnetic field of several kG and have current density ~100 A/sq. cm. voltage ~100 V, density ~2×10^{14}/cm^3, electron temperature ~1 eV, and ion temperature ranging from 2 eV in hydrogen to 32 eV in argon. Temperatures were determined spectroscopically. The arc column is essentially completely ionized and consists largely of doubly charged ions (except in hydrogen). The current is carried by a small fraction (~0.02) of the electrons having temperature 20 to 30 eV—much higher than the main electron population. These fast electrons control the conductivity at a sufficiently high value to make the longitudinal electric field very small. They acquire energy in passing through the cathode sheath and lose it in Coulomb collisions with slow electrons, in ionizing and exciting ions, and in exciting drift waves. In spite of these losses, they reach the anode with energies of 20 to 50 eV. More than half of the input power to the argon arc is radiated in the vacuum ultraviolet. Azimuthally propagating drift waves are present at ~35 kc and in the range 150 kc to several Mc. The latter are excited by the fast electrons and heat the ions by cyclotron absorption. Dispersion relations for these waves are presented. (auth)

7207 (AD–634083) TRANSIENT SIGNAL PROPAGATION IN LOSS-LESS: ISOTROPIC PLASMAS. VOLUME I. Physical Sciences Research Papers. Haskell, Richard E.; Case, Carl T. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Apr. 1966. 56p. (AFCRL-PSRP–212; AFCRL–66-234). CFSTI $3.00 cy, $0.65 mn.

The concept of the wave packet is used to obtain some general results on the propagation of signals in dispersive media. The dispersion of a Gaussian carrier pulse and a square wave carrier pulse in an isotropic plasma is carried out using the wave packet concept. A general analysis of transient wave propagation in isotropic plasmas is given using Laplace transform methods. Solutions are given in terms of series solutions which may be expressed in terms of Lommel functions. Integral solutions which can be easily evaluated numerically are derived using the convolution theorem and using contour integration techniques. The solutions are useful for short dispersion lengths. (auth)

7208 (AD–638677) PROGRESS IN THE STUDY OF HALL CURRENT ACCELERATION. Final Report, June 1, 1965–May 31, 1966. Measures, R. M. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Contract AF-AFOSR-944-65. 29p. (AFOSR–66-1858). CFSTI $3.00 cy, $0.65 mn.

The capacitor bank necessary for the Hall-current acceleration study has been designed and developed. The multi-cusp magnetic field configuration has been optimized to simulate as close as possible the model assumed in the theory of Haines for the Hall acceleration of a plasma. Experience has also been gained in the use of spectroscopic diagnostics of hot, dense plasmas. The electron number density and temperature, behind a strong shock wave, have been evaluated from a study of the H_β line. (auth)

7209 (BMwF-FBK–66-27) UNTERSUCHUNGEN AN DICHTEN PLASMEN. (Investigations of Dense Plasmas). Meiners, D. (Bundesministerium fuer Wissenschaftliche Forschung, Bad Godesberg (West Germany)). July 1966. 42p. (In German). Dep. mn. DM 7,40.

The following problems of plasmas of high particle densities (electron density n_e 10^{18} cm^{-3}) have been studied: (1) experimental investigation of dwell time and reignition phenomena of exploding wires and comparison with the theory of detonation, (2) development of a spark gap for exploding wire experiments at 100 kV, (3) enhancement of shock wave velocity by heating the gas within the driver section of a conventional shock tube by means of a discharge initiated by an exploding wire, and (4) development of a photographical method to determine the absorption coefficient within instationary and inhomogeneous dense plasmas of high optical thickness. (auth)

7210 (N–66-27315) STUDY OF MAGNETIC ANNULAR PLASMA ACCELERATOR. Summary Report, April 15, 1964–January 14, 1966. Patrick, R. M.; Schneiderman, A. M. (AVCO-Everett Research Lab., Everett, Mass.). 1966. Contract NAS3-5748. 126p. (NASA-CR–54686). CFSTI $3.00 cy, $0.65 mn.

Experimental and analytical studies were conducted to obtain high propulsive efficiencies in the 2000 to 3500-sec specific-impulse range with a magnetic annular arc (Maarc). An axisymmetric geometry was chosen, consisting of a central cathode and an axisymmetric anode surrounded by a solenoidal magnetic field. Local diagnostic techniques used to calculate density and velocity profiles are described. The voltage characteristics of the device with various propellants and bias field intensities were investigated; it was found that the voltage is linearly dependent on the intensity and is a function of the propellant and the B field geometry. Thrust profile measurements show that both the magnitude of the total thrust and the thrust density profile are very sensitive to the magnetic field intensity and shape. Local mass flow distributions, measured in the plasma jet, indicate that the ambient tank gas mixes with the plasma issuing from the Maarc nozzle. Axial and radial current distribution in the plasma flow was also measured. Results indicate that the Maarc is capable of producing a steady axisymmetric discharge in such propellants as nitrogen, hydrogen, ammonia, helium, and argon at power levels from 10 to 200 kW. (STAR)

7211 (TID–23459) QUARTERLY PROGRESS REPORT NO. 83 [ON ELECTRONICS]. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Oct. 15, 1966. Contract AT(30-1)-1842. 204p. (RLE-QPR–83). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Separate abstracts were prepared for 6 of the included sections. The remaining sections were not in the scope of NSA and hence omitted. (M.O.W.)

For abstracts of individual sections see: 6907, 7047, 7132, and 7212–7214.

7212 (TID–23459, pp 65-77) PLASMAS AND CONTROLLED NUCLEAR FUSION. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

The plasma density as a function of time was measured, using a TM_{010} cavity-mode shift technique and an 8-mm Fabry–Perot interferometer, for a beam-plasma discharge system operating with "Asco" and Marshall valve systems. A brief analysis of high-frequency electron phonon interactions in a magnetic field was made. (M.O.W.)

7213 (TID–23459, pp 59-64) GASEOUS ELECTRONICS. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

In a previous report, exacting information was discussed for the velocity distribution of electrons in a plasma from measurements of the spectrum of the emitted microwave radiation. A more extensive theoretical treatment of the problem is now presented. (M.O.W.)

7214 (TID–23459, pp 37-58) PLASMA PHYSICS. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

A calculation is given of an ion–wave instability that can occur in a steady state discharge in which no electric current exists. The calculation assumes that all other plasma instabilities are absent. Further research on the passage of laser beams through plasma is reported. Observations of microwave scattering from

density fluctuations in an electron-beam-produced plasma have continued. These observations are discussed. (M.O.W.)

7215 VELOCITY OF A PLASMA JET. Yurevich, F. B.; Volk-Levanovich, M. V. (Inst. of Heat and Mass Exchange, Academy of Sciences, Belorussian SSR). Vestsi Acad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 1, 125-8(1966). (In Russian).

Velocity measurements were made of a plasma jet by determining the brightness fluctuations. The plasma was produced at the output of a plasmatron with vertical gas stabilization of the arc. The velocity was measured with a high speed streak camera (SFRO operating in the photorecording mode with mirror rotation of 3000 to 7500 rpm), corresponding to a linear sweep of 150 to 375 m/sec. A special template was used to measure the radial velocity distribution. The jet velocity was measured for different plasmatron conditions, with and without a mixing chamber (damper chamber). The results show that the mixing chamber greatly smears out the brightness fluctuations. The obtained plasma velocities and other parameters are listed in a table. The results show that the distributions of the velocity on the jet axis are close to the mean values calculated by the heat balance. The radial distribution of the velocity in the jet is steeper for a plasmatron without a mixing chamber than for one with a mixing chamber. When the different velocity profiles are plotted in dimensionless form, they all coincide in form and fit quite well an empirical equation $\overline{W} = -0.4\bar{r}^2 + 1$, where $\overline{W}$ is the ratio of the relative jet velocity at a given radius to the velocity on the axis, and $\bar{r}$ is the ratio of the running radius to the radius of output nozzle. The accuracy of the results is estimated at ±10%. (ATD)

7216 DISPERSION OF MAGNETOHYDRODYNAMIC AND MAGNETOSONIC WAVES IN AN IDEAL MEDIUM. Novikov, G. G. Dokl. Akad. Nauk Tadzh. SSR, 7: No. 11, 10-14(1964). (In Russian).

The effect of electron inertia on the propagation of waves in plasma is examined. It has been established that electron inertia leads to the dispersion of magnetohydrodynamic and accelerated magnetosonic waves even in a theoretically ideal plasma. The effect was observed in the short-wave range. (ATD)

7217 ULTRASOUND IN ELECTRON–ION PLASMA. Bogdanov, A. V. Uch. Zap. Moskov. Obl. Pedagog. Inst., 147: 193-9(1964). (In Russian).

Longitudinal oscillations of a uniform plasma are investigated in the scope of the kinetic method of Bhatnagar et al. An additional term describing the effect of the ultrasonic field on the charged particles is introduced in the kinetic equation. The investigation is conducted in the linear nonisothermal approximation, taking into account collisions of charged particles (electron–electron and ion-ion). The theory of ionic oscillations is constructed in complete analogy to the theory of electronic oscillations under the conditions: for the electron and ion temperatures $T_e \gg T_i$ and the fast electrons create a background compensating the average ion charge. Expressions for the charge density amplitudes as a function of the frequency and amplitude of the ultrasonic potential are obtained. The resonance character is shown for ultrasonic excitation of the plasma near the natural oscillation frequencies of the electrons ν_e and ions ν_i. For the plasma in a neon gas discharge tube $\nu_e \approx 9 \cdot 10^9$ Hz and $\nu_i \approx 4.6 \cdot 10^6$ Hz. (ATD)

7218 ANGULAR DISTRIBUTION OF RADIATION SCATTERED COHERENTLY BY A PLASMA CYLINDER. Jones, A. R.; Wooding, E. R. (University Coll. of Wales, Aberystwyth). J. Appl. Phys., 37: 4670-5(Dec. 1966).

The intensity and phase of a wave scattered by a cylindrical plasma column were computed for the case where R/λ_f is near unity. The angular distribution of intensity was measured when a 9.6-GHz plane wave was incident on a plasma of 2.68-cm radius with the electric vector parallel to the cylinder axis. The variation of phase with angular position was also determined. A resonance was observed. (auth)

7219 CONDUCTIVITY CALCULATIONS FOR A PLASMA ACCELERATED BY PROGRESSIVE WAVES. Rager, Jean-Pierre. Compt. Rend., Ser. A, 263: 512-15(Oct. 10, 1966). (In French).

A first approximation for the current density induced in a plasma accelerated by progressive waves is calculated and it is found to be proportional to ½ of the electric field. The experimental results seem to justify the theory presented. (tr-auth)

7220 FIRST-ORDER COUPLED WAVE EQUATIONS FOR PROPAGATION IN STRATIFIED COMPRESSIBLE PLASMAS. Burman, R. (Victoria Univ., Wellington, New Zealand). Austral. J. Phys., 19: 747-57(Dec. 1966).

Wave propagation in planar stratified, continuously varying, compressible, nonmagnetized electron plasmas is discussed. The waves are coupled electromagnetic and electron acoustic waves and are described by Maxwell's equations coupled to the linearized single-fluid equations of hydrodynamics. Some first-order coupled wave equations are obtained and are transformed into convenient forms. Coupling, power flow, and approximate solutions are then discussed. (auth)

7221 MOVING STRIATION IN HIGH-FREQUENCY DISCHARGE PLASMA. Takeyama, Mikio (Kyoto Univ.); Yamasaki, Sozaburo; Shimada, Masatoshi. J. Phys. Soc. Jap., 21: 2415-16 (Nov. 1966).

A self-excited moving striation was observed in a stationary high-frequency discharge plasma under no external dc electric field. The measurements were made on a discharge tube having one electrode 7 cm from one end and filled to a pressure of 0.26 torr with pure argon. The amplitude of oscillation increased exponentially to a maximum and then decreased gradually with wave progression. The self-excited moving striation observed had a frequency of 1.46 kc, a phase velocity of 50.9 m/sec, and a wavelength of 3.49 cm. (A.G.W.)

7222 ENHANCED DIFFUSION AND HIGH-FREQUENCY OSCILLATION IN A PLASMA. Kawasaki, Eiichi (Nihon Univ., Tokyo); Kawabe, Takaya; Koganei, Mikiko; Kato, Kiyoe. J. Phys. Soc. Jap., 21: 2419(Nov. 1966).

The connection between enhanced diffusion and high-frequency oscillation was studied using a hot-cathode diode-type discharge in Hg vapor. There was observed a critical magnetic field above which the diffusion increased with the magnetic field and was accompanied by the high-frequency oscillation. The critical magnetic field depended on the discharge current or the density of the charged particles. (A.G.W.)

7223 HIGH-FREQUENCY AND LOW-FREQUENCY OSCILLATIONS IN A PLASMA IN A MAGNETIC FIELD. Kato, Kiyoe (Electrotechnical Lab., Tokyo); Kawabe, Takaya; Koganei, Mikiko; Kawasaki, Eiichi. J. Phys. Soc. Jap., 21: 2421(Nov. 1966).

The connection between high-frequency electron oscillations and low-frequency ion oscillations was studied in magnetic fields up to 450 G applied parallel to the direction of the discharge current. Plots of the high-frequency and low-frequency oscillations against the magnetic field and the discharge current confirm that for those values of the magnetic field and the discharge current at which the high-frequency electron oscillation is strong, the low-frequency ion oscillation also has large amplitude, and that the low-frequency oscillations have discrete structure. (A.G.W.)

7224 ANOMALOUS RADIO-FREQUENCY EMISSION AT ELECTRON CYCLOTRON FREQUENCY IN PARTIALLY IONIZED PLASMAS. Tanaka, Shigetoshi; Takayama, Kazuo (Univ. of Nagoya, Japan). J. Phys. Soc. Jap., 21: 2372-80(Nov. 1966).

The anomalous emission at the electron cyclotron frequency in partially ionized plasmas was studied in the range of radio frequency below 1000 Mc. An anomalous emission could be observed when the detecting frequency f exceeded a critical frequency f_{crit}, which was in the range from 40 to 70 Mc, somewhat smaller than the collision frequency of plasma electrons. Another anomalous emission was observed when f was smaller than f_{crit}. The anomalous second harmonic observed resulted from a frequency multiplying of the anomalous cyclotron emission. (auth)

7225 LANDAU DAMPING. Ahier, Georges (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B. 263: 803-6(Oct. 3, 1966). (In French).

It is shown that the Fourier space transforms of Vlasov's equations can be put into integral equations. In particular, the field obeys one of the Volterra equations of the second type, and this allows theoretical processes to be introduced along with the methods for practical study and solution. A transient signal can more or less mask the Landau effect. The conclusions present the problem in a new light. (tr-auth)

7226 KINETIC THEORY OF LAYERED-PLASMA WAVEGUIDE IN A STRONG MAGNETIC FIELD. Kondratenko, A. N. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 1065-72(1966). (In Russian).

The attenuation coefficients are found and the conditions of propagation of the high- and low-frequency oscillations are determined in a layered-plasma waveguide placed in a strong magnetic field. (auth)

7227 CHARGE RADIATION IN MEDIUM WITH CONVECTIVE INSTABILITY. Chugunov, Yu. V. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 1151-4(1966). (In Russian).

The radiation reaction of a charge moving uniformly through interpenetrating media is found from solving the problem with zero initial conditions. The work of a longitudinal field on the charge is shown to increase exponentially in time if the charge velocity is less than the flux one. (auth)

7228 CALCULATION OF SOME TRANSITION PROCESSES OF A NONLINEAR ELECTRIC FIELD IN A GAS IONIZED BY RADIATION. Rozenkrants, A. S. Izv. Vyssh. Ucheb. Zaved., Energ., No. 2, 19-25(1966). (In Russian).

Similarity methods are applied to the solution of a problem describing nonlinear discharge processes arising due to space charge in gases ionized by radiation. The rate equations for singly ionized species are written for parallel plate geometry and applied to those problems where ionic diffusion can be neglected; both constant and varying applied potentials are treated. The rate equations are rewritten in dimensionless form and solved numerically. The form of equation and selection of proper dimensionless parameters lead to a solution for a large range of parameters with a manageable number of computations. Selected results are given to illustrate the behavior of current density, ion and electron concentrations and potential distributions. The analytic method described here is useful for predicting actual behavior of discharges in an ionizing radiation environment in which such components as radiation counters, electronic tubes, and insulators may be found. (ATD)

7229 BEHAVIOR OF SEPARATION CONSTANTS FOR FINITE GYROTROPIC PLASMAS. Bevc, Vladislav (Aerospace Corp., El Segundo, Calif.). IEEE (Inst. Elec. Electron. Eng.). Trans. Antennas Propagation, AP-14: 804(Nov. 1966).

Previously published contour diagrams, relating to the behavior of separation constants for finite, axially magnetized, cold collisionless plasma, are supplemented with a more detailed graphical presentation of the situation near the boundary of the complex region. The general appearance of contour diagrams is illustrated. The values of the separation constants at the origin of the $\omega-\beta$ plane depend on the path along which the origin is approached. If the origin is approached along the left boundary of the complex region, the value of separation constants at the origin is $j[1 + (\omega_H/\omega_p)^2]^{-\frac{1}{4}}$ while the value obtained by approaching the origin along the left boundary is $[1 + (\omega_H/\omega_p)^2]^{-\frac{1}{4}}$. (BBB)

7230 WAVE PROPAGATION IN ISOTROPIC WARM PLASMAS. Unz, H. (Univ. of Kansas, Lawrence). IEEE (Inst. Elec. Electron. Eng.) Trans. Educ., E-9: 149-54(Sept. 1966).

In this analysis the plasma in the ionosphere is considered to be neutral, uniform, unbound, and in equilibrium. It is further assumed that the electron gas is warm and compressible, and that there is no net static magnetic field ($\bar{H}_0 = 0$) and no net static electric field ($\bar{E}_0 = 0$). The general equations of the electromagnetoplasma gasdynamic (EMPGD) theory are given in general, and the different variables are defined from the macroscopic point of view, taking into account the fluid-dynamic variables of the perfect electron gas. The equations are then linearized for small signal theory and are written for harmonic time variation $e^{+j\omega t}$. The magnetic field wave equation and the acoustic wave equation for 3 dimensions are derived, and the corresponding phase velocities are found. The velocity field and the electric field wave equations in 3 dimensions are also derived, and they are separated into the 2 corresponding parts of the magnetic and acoustic waves in a manner similar to that in the theory of elasticity. (BBB)

7231 VARIATIONAL TECHNIQUE FOR DETERMINING THE PROPAGATING MODES OF A FINITE PLASMA. Jha, S. S. (Tata Inst. of Fundamental Research, Bombay); Kino, G. S. J. Electron. Contr., 14: 167-85(Feb. 1963).

Calculations were carried out by a variational method to determine the propagating characteristics of a slow wave mode along a finite plasma column. The density of the column was assumed to be nonuniform, and to have a variation of the form $n = n_0(1 - \alpha r^2/a^2)$, where a is the radius of the column. Rayleigh-Ritz procedures were used to determine the best approximation for the rf field variation over the cross section. For this purpose, a set of Jacobi orthogonal polynomials was constructed which are orthogonal over the cross section of the plasma. Both the dc density variation of a plasma and the rf field variations within the plasma were expressed in terms of this set of polynomials. This procedure yielded results in good agreement with an exact field theory in the range $\beta a < 2$, where β is the propagation constant. For small βa, the propagating characteristics depend on the average value of the density within the column. (BBB)

7232 VELOCITY DEPENDENCE OF THE COULOMB LOGARITHM AND THE TEMPERATURE EQUALIZATION OF ELECTRONS AND ION IN A PLASMA. Nishimura, Keiichi (Univ. of California, Livermore). Phys. Rev., 152: 177-81 (Dec. 2, 1966). (UCRL-14900-T(Rev.1)).

The Coulomb logarithm is customarily evaluated for some averaged value of the relative velocity with which pairs of particles collide. In the problem of calculating the rate of energy transfer between electrons and ions, however, the high ratio of their masses makes the velocity dependence of the Coulomb logarithm important. To illustrate this point, the rate of energy transfer was first calculated using the traditional theory based on the Boltzmann equation with the velocity dependence of the Coulomb logarithm taken into consideration at the final stage. To further illustrate the point, the calculation was repeated using Bogoliubov's plasma kinetic equation containing dynamic shielding effects from the outset. Both calculations predict that the error due to the use of a velocity-independent Coulomb logarithm will be 4 to 10% in situations where the Coulomb logarithm is 10 to 16. (auth)

7233 RECOMBINATION OF He^+ AND He^{++} IN THE AFTERGLOW OF A HELIUM DISCHARGE. Mosburg, Earl R. Jr. (National Bureau of Standards, Boulder, Colo.). Phys. Rev., 152: 166-76(Dec. 2, 1966).

Studies of the time dependence of atomic and molecular light intensities, electron density, atomic metastable densities, and electron temperature have allowed the determination of the He^+-electron and He^{++}-electron recombination coefficients as functions of electron density and temperature. The results are in reasonable agreement with the theory of collisional-radiative recombination. The mechanisms controlling metastable densities and heating of the electron gas are discussed. In particular, the disappearance of the 2^3S metastable atom seems best explained in terms of collisional de-excitation by electrons. (auth)

7234 MAGNETIC CORRECTIONS TO THE BOLTZMANN TRANSPORT EQUATION. Thomas, R. B. Jr. (General Electric Co., Valley Forge, Pa.). Phys. Rev., 152: 138-49(Dec. 2, 1966).

The usual derivations of the Boltzmann transport equation suffer from a number of weaknesses. A simple model is used to treat on as rigorous a basis as possible the influence of a magnetic field on the transport equation. The approach presented establishes the relationship between the classical Boltzmann equation and the corresponding quantum-mechanical formalism. It is shown how the exact gauge-dependent Liouville equation, determining the density matrix, can be transformed into a completely gauge-independent equation satisfied by a new density matrix. This equation is solved for a model consisting of noninteracting free electrons being elastically scattered by randomly placed scattering centers. The new density matrix is developed in ascending powers of the strength of the scattering potential. In carrying out this development, the product of the cyclotron frequency and the collision relaxation time is assumed to be of order unity. In this case the familiar Boltzmann transport equation in the presence of a magnetic field represents an approximation valid in the limiting cases of very weak or very dilute scatterers. The corresponding velocity operator is shown to be the usual gauge-independent expression, just the ordinary free-particle momentum operator divided by the mass. Higher order corrections to the transport equation are found, some of which involve the magnetic field. (auth)

7235 RELATION OF THE PLASMA KINETIC EQUATION FOR THE DARWIN HAMILTONIAN TO THE RELATIVISTIC LANDAU EQUATION. Krizan, John E. (Univ. of Vermont, Burlington). Phys. Rev., 152: 136-7(Dec. 2, 1966).

The connection between the two-particle ring term for the kinetic equation with Darwin interaction and the $(v/c)^2$ approximation of the relativistic Landau equation is demonstrated. It is suggested that for practical calculations of $(v/c)^2$ corrections, an equation (with cutoffs) given might be used instead of the more complete kinetic equation (with ring-sum term and without cutoffs) derived recently. (auth)

7236 KINETIC THEORY OF QUANTUM PLASMA AND RADIATION IN AN EXTERNAL MAGNETIC FIELD. Chappell, Willard R. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Phys. Rev., 152: 113-20(Dec. 2, 1966).

The random-phase approximation and the Bogoliubov (adiabatic) assumption are used to obtain long-time expressions for electron and photon operators in the presence of a constant, external magnetic field. These operators are then used to obtain a kinetic equation describing the approach to equilibrium of the system. The results include the dynamical screening of the Coulomb interaction and the "dressing" of the photons. Expressions are also obtained for the density and electric-field autocorrelation functions. The structure of the asymptotic ($t \to \infty$) operators is studied, and it is shown that operators can be obtained that correspond to the creation and annihilation operators for the collective modes of the system. (auth)

7237 STRUCTURE OF A SHOCK WAVE PROPAGATING TRANSVERSELY TO A MAGNETIC FIELD IN A PLASMA. Pataraya, A. D. (Tbilisi Inst. of Physics, USSR). Zh. Tekh. Fiz., 36: 1320-2(July 1966). (In Russian).

Dispersion equations for the regions before and behind the shock front were derived from the equations of motion, Maxwell's equations, and the equation of continuity. These dispersion equations are presented and their solutions are discussed for the case when

magnetic viscosity is significant. The values of quantities characterizing the plasma are tabulated for 8 different cases. From the tabulated data it is concluded that the magnetic field strength increases monotonically in front of the shock wave, but that behind the shock wave the magnetic field may either approach the unperturbed value monotonically, or it may execute damped oscillations, depending on the significance in each particular case of electron inertia. (TSS)

7238 KINETIC THEORY OF THE PASSAGE OF WAVES THROUGH A PLASMA LAYER IN A WAVEGUIDE. Kondratenko, A. N. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 11: 1045-55(Oct. 1966). (In Ukrainian).

The passage of electromagnetic waves through a plasma layer in a waveguide with metal walls was investigated. The plasma is in a strong magnetic field, so that motion of the plasma particles across the field is neglected. The coefficient of wave energy absorption by the layer is found in the following cases: (a) weak space dispersion, when $\omega a \gg v_e$ in a homogeneous layer with motion of ions neglected and an arbitrary law of plasma electron reflection from the layer boundaries, (b) a layer inhomogeneous at the edges, neglecting thermal motion of the particles, (c) a thin ($v_e \gg \omega a \gg v_i$) homogeneous layer and a mirror law of plasma particle reflection from the boundaries, and (d) a thin layer of arbitrary inhomogeneity and a diffuse law of particle reflection from the boundaries. (auth)

7239 X-RAY SPECTRA PRODUCED BY THERMAL BREMSSTRAHLUNG. Hovenier, J. W. (Univ., Leiden). Bull. Astron. Inst. Neth., 18: 185-7(Jan. 1966).

The spectra produced by the thermal bremsstrahlung of a gas in the 2- to 10-Å range with accurate Gaunt factors and for temperatures from 5×10^6 to 5×10^{8}°K were calculated. The Gaunt factor involves hypergeometric functions of complex variables. According to Brussaard and Van de Hulst for the frequencies in the 2- to 10-Å range and for electron energies smaller than about 13 keV the Born–Elwart approximation formula may be applied to give results within a 1% error. Formulas are developed for the case where a plasma is not wholly composed of hydrogen, that is, when the ions are other than protons. (Int. Aero. Abstr.)

7240 ELECTRODE EFFECTS IN A SEEDED PLASMA. Wolf, Randolph J. (Cornell Univ., Ithaca, N. Y.). Contract AF 49(638)-1346. AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 4: 2155-9(Dec. 1966).

Current-voltage characteristics of stagnation point electrodes embedded in a cylindrical probe were obtained for a lightly ionized, atmospheric pressure plasma. The probe characteristics were determined as functions of electrode temperature and seed material. A seeded ethyl alcohol–air flame exhausting into the atmosphere served as the plasma source. Saturation currents were measured which were independent of the electrode temperature below 600°K and increased rapidly when the electrode temperature was increased above 600°K. The properties of the combustion products are calculated using measured temperatures and including partial dissociation of the seed molecules and electron attachment to the hydroxyl radical. Resistances calculated from the freestream electrical conductivity are in good agreement with the measured values. The dependence of the saturation currents on the electrode temperature is explained by thermal emission of electrons from the electrodes. The magnitude of the saturation currents for temperatures greater than 600°K is in agreement with the Richardson equation if the work function of the steel electrodes is taken to be 1.8V. (auth)

7241 FARADAY ROTATION MEASUREMENT OF TRAPPED MAGNETIC FIELDS IN A THETA PINCH PLASMA. Bogen, P.; Rusbueldt, D. (Kernforschungsanlage, Juelich, Ger. Landes Nordrhein-Westfalen, Ger.). Phys. Fluids, 9: 2296-8(Nov. 1966).

Using a 3.39-μ He–Ne laser, trapped fields of -4 to $+8$ kG were measured in a 45-kG driving field ($\beta > 0.97$) when no bias field was applied. With antiparallel bias field, no trapped field reversal was observed at high densities. (auth)

7242 LINEARIZATION OF THE OSCILLATIONS IN A PLASMA SLAB. Schneider, H. M. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 9: 2298-2301(Nov. 1966).

A discrete model was used to study oscillations in a finite plasma with two types of boundaries. The numerical results which are presented show that the coherent motion is gradually destroyed by a "scrambling" which initially occurs near the surface. (auth)

7243 TRANSPORT PROCESSES IN A MULTICOMPONENT ASSEMBLY. II. FOKKER–PLANCK FORMALISM. Devanathan, C.; Raghavachar, M. R.; Babu, Ram (Indian Inst. of Science, Bangalore, India). J. Indian Inst. Sci., 48: 81-97(Apr.-July 1966).

It has been pointed out that when the charged particles of a multicomponent assembly interact according to comparatively long-range Coulomb forces, small random deflections of the particles are very effective in the evolution of the distribution function. Such small random deviations are incorporated into the kinetic equation by using the Fokker–Planck formalism. The distribution functions are expanded in terms of the generalized Hermite polynomials and, following Grad, a consistent set of transport equations is deduced. It is found that the Fokker–Planck term enhances the relaxation times of all the physical variables and thereby decreases the electric conductivity. Apart from the anisotropy due to the magnetic field among the stresses, F–P terms introduce an additional bulk viscosity term. Further they introduce intense anisotropy among heat-flux tensors. Modified expressions for viscosity, thermal conductivity, and electric conductivity have been deduced. (auth)

7244 TURBULENCE OF A LOW-β PLASMA. D'Angelo, N.; Enriques, L. (Princeton Univ., N. J.). Phys. Fluids, 9: 2290-1 (Nov. 1966). (MATT-409)

The fluctuation spectra of Cs and K plasmas were measured in the Q-3 device. They appear to be in agreement with a recent prediction by Chen. (auth)

7245 MINIMUM-B SUPPRESSION OF OSCILLATIONS IN A Q DEVICE. Decker, John A. Jr. (Sperry Rand Research Center, Sudbury, Mass.). Phys. Fluids, 9: 2291-3(Nov. 1966).

The "minimum-B" magnetic field geometry provided by the combination of a transverse quadrupole-cusp field with a uniform axial field suppresses certain of the low-frequency oscillations spontaneously present in the cesium plasma of the "Topsy" Q device with a uniform magnetic field. (auth)

7246 INTERACTION OF PLASMONS. Chang, David B.; Drummond, William E. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 9: 2254-62(Nov. 1966).

The nonlinear interaction between plasma oscillation normal modes is studied in a hydrodynamic approximation. A modified quasilinear treatment is used, in which the normal modes are taken to affect each other through the slow nonlinear temporal and spatial changes they induce in the (equilibrium) background quantities. Plasmons, i.e., wave packets of plasma oscillations, are found in this approximation to have an interaction similar in form to the electromagnetic interaction. The plasmon interaction is describable in terms of scalar and vector potentials which satisfy wave equations of the form satisfied by their electromagnetic counterparts. Here, quantities proportional to the slow changes induced in the background number and current densities play the roles of the scalar and vector potentials, with the thermal velocity corresponding to the speed of light. The source terms in the potential wave equations are quadratic in the normal mode density perturbation. The normal mode density perturbation in turn satisfies a Klein–Gordon-like equation, so that, normalized, it would appear to play a role similar to the quantum-mechanical probability wave function Ψ. The nonlinear interaction leads to an instability with a growth rate proportional to the square root of the ratio of the plasma oscillation energy to the background thermal energy. (auth)

7247 EXCITATION OF ELECTROSTATIC ION CYCLOTRON OSCILLATIONS. Levine, A. M.; Kuckes, A. F. (Princeton Univ., N. J.). Phys. Fluids, 9: 2263-6(Nov. 1966). (MATT-418).

It was observed that an electron current drawn to an electrode immersed in a magnetized plasma can excite oscillation near the ion cyclotron frequency. A theory is derived which predicts such oscillation due to a destabilizing influence of the sheath voltage drop at the electrode on the plasma column. Experimental evidence is presented which shows that the present theory is more compatible with observations than an earlier explanation in terms of resonantly drifting electrons. (auth)

7248 EXCITATION OF WAVES IN A COMPRESSIBLE PARTIALLY IONIZED PLASMA BY SOURCES OF DIFFERENT KINDS. Samaddar, S. N. (Raytheon Co., Sudbury, Mass.). Phys. Fluids, 9: 2267-73(Nov. 1966).

A three-fluid isotropic homogeneous compressible plasma is described by a set of linearized hydrodynamic and Maxwell's equations containing acoustic (or mechanical) and electromagnetic sources. It is shown, in general, that under suitable assumptions, these equations can be decomposed into transverse electromagnetic waves and longitudinal plasma–acoustic waves. Though the total fields can be decomposed in this manner, the total energy (or the Poynting vector) cannot be expressed as the sum of the energy associated with electromagnetic fields and plasma–acoustic fields alone. That is, there is an energy trans-

fer between these two decomposed waves due to collisions among the plasma elements. (auth)

7249 COLLISIONLESS THEORY OF A PLASMA SHEATH NEAR AN ELECTRODE. Hu, Pung Nien; Ziering, Sigi (Space Sciences, Inc., Waltham, Mass.). Phys. Fluids, 9: 2168-79(Nov. 1966).

The existing collisionless theory of a plasma sheath near an infinite planar electrode is examined in detail. Ranges of validity as well as difficulties with the existing sheath models are investigated. The assumption of monoenergetic particle distributions, as used for instance in "Bohm's sheath criterion," restricts the usual analysis. To remove this difficulty Maxwellian particle distribution functions are assumed. In addition, microscopic boundary conditions are assumed to incorporate the respective electrode and plasma parameters. A new sheath model is then developed without imposing the usual sheath criterion for the conditions specified at the sheath edge. Explicit results for the current–voltage relation and for the sheath thickness are obtained for the improved sheath model proposed in this study. Other important physical quantities are expressed in terms of the electrostatic potential, which can be calculated by a quadrature subject to the physical parameters to be specified. The general solution reduces to a simple analytic form for the special case where the temperature of the electrons, ions, and the electrode are identical. (auth)

7250 STEADY, OBLIQUE, NONLINEAR WAVES IN A WARM COLLISION-FREE PLASMA. Kever, H.; Morikawa, G. K. (New York Univ.). Phys. Fluids, 9: 2180-9(Nov. 1966).

The speed and structure of steady nonlinear waves, moving with uniform velocity in an oblique direction across a magnetic field in a collision-free plasma with temperature, are obtained. This is a self-consistent formulation in which the plasma motion is governed by the Vlasov equations for ions and electrons coupled to the Poisson–Maxwell equations. This problem can be solved in the limiting case of small-amplitude nonlinear waves if the same scaling laws are assumed to hold for the warm plasma as those for a cold plasma. Both compression and rarefaction waves are possible depending on the obliqueness angle and plasma temperature. The critical transition angle increases rapidly with increasing ion temperature but is practically unaffected by increasing electron temperature alone. (auth)

7251 OHM'S LAW IN MULTICOMPONENT NONISOTHERMAL PLASMAS WITH TEMPERATURE AND PRESSURE GRADIENTS. Demetriades, S. T.; Argyropoulos, G. S. (STD Research Corp., Pasadena, Calif.). Phys. Fluids, 9: 2136-49(Nov. 1966).

A closed set of transport equations with collision terms evaluated by the 13-moment approximation is used, under well-defined assumptions, to derive a generalized Ohm's law in multicomponent nonisothermal plasmas as a function of the electric and magnetic fields and the temperature and pressure gradients. The nine coefficients defining this dependence are obtained in two successive approximations and are expressed in terms of component properties for any number N of components in the plasma, each component having its own temperature. The matrixes and determinants involved in these expressions are of order N. Results obtained for N = 4 and 5 allow the investigation of new effects that cannot be studied with the available 3-fluid expressions. It is shown that the only temperature gradient that needs to be considered in Ohm's law is that of the electrons and that all plasma properties, except those that describe or include interactions between heavy components, must be determined at the electron temperature. It is concluded that interactions between heavy particles cannot always be neglected in favor of electron–heavy particle interactions and that the results of this study may be used for a more general evaluation of all the coefficients of Ohm's law in multicomponent nonisothermal plasmas. The results are valid for any degree of ionization greater than approximately 10^{-7} and are presented in a form useful for many applications. (auth)

7252 ELECTRIC FIELDS CAUSED BY THE DIFFUSION OF CHARGED PARTICLES ACROSS A MAGNETIC FIELD. Schwirzke, Fred (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 9: 2244-9(Nov. 1966). (GA-7016).

Plasma density, electron temperature, and potential distribution were measured across and along the magnetic field for a determination of the effective ion and electron-diffusion coefficients in a cylindrical plasma column of finite length which is given by conducting end walls. Ion and electron flux to the end walls were measured. The potential across the magnetic field was recorded as a function of magnetic induction B, pressure P, and length L. The observed radial electric field, E_r, is opposite in sign to the density gradient and is related to the electron temperature gradient. When a plasma contacts a wall, a potential drop proportional to the electron temperature, T_e, is present over the sheath which impresses on the plasma a positive potential in relation to the grounded end walls. When T_e gradually decreases perpendicular to B owing to electron collisions with cold gas particles, the plasma potential decreases proportionately and an outward directed E_r is built up, which enhances the plasma loss across the magnetic field. (auth)

7253 NONLINEAR EFFECTS IN A PLASMA WAVEGUIDE (DEPENDENCE OF THE PHASE VELOCITY ON THE AMPLITUDE). Ivanov, B. I. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 11: 539-41(1966). (In Ukrainian).

Nonlinear effects play an important role during the propagation of electromagnetic waves in plasma, especially in a plasma waveguide, if the velocity v of the plasma particles acquired by interaction with the wave is comparable with the phase velocity v_{ph}. Experiments were carried out to determine this nonlinear correlation, using a copper waveguide placed in the magnetic field and heating the plasma by dc discharge. In order to eliminate the competing nonlinear mechanisms, such as the ionization, low-power generators were used because they interfere only slightly with the plasma. The experiment was carried out at low frequency (about 1 MHz) and low v_{ph} in a low-density, $n = 10^9$ to 10^{10} cm^{-3}, system. The nonlinear addition to the generated high-frequency signal was measured separately. It was found that, in addition to the nonlinear effects observed in the absence of collisions, similar effects attributable to the conductivity changes of the plasma may be also observed. (TTT)

7254 NONLINEAR SECOND HARMONIC GENERATION IN AN INHOMOGENEOUS MAGNETOPLASMA. Sodha, Mahendra S.; Kaw, Predhiman K. (Indian Inst. of Tech., New Delhi). J. Phys. Soc. Jap., 21: 2674-83(Dec. 1966).

The nonlinear generation of the second harmonic component of the current density in an inhomogeneous plasma in the presence of a magnetic field was studied analytically; the results were used in studying the nonlinear growth of the second harmonic of an electromagnetic wave in an inhomogeneous magnetoplasma and on reflection from an inhomogeneous magnetoplasma-free space interface when the electromagnetic wave is propagating along the direction of the external magnetic field. Some numerical results depicting the phenomenon of resonances in the second harmonic component of current density and in the second harmonic components of the reflected wave were also presented. (auth)

7255 ON NONLINEAR GENERATION OF SECOND HARMONIC AND SUM AND DIFFERENCE FREQUENCIES IN A HOMOGENEOUS PLASMA. Sodha, Mahendra S.; Kaw, Predhiman K. (Indian Inst. of Tech., New Delhi). J. Phys. Soc. Jap., 21: 2684-94(Dec. 1966).

A new mechanism for the generation of even harmonics and sum and difference frequencies in a plasma, which consists of simultaneous application of a dc electric field and two alternating electric fields, was analyzed. The Boltzmann transfer equation for electrons in a homogenous plasma in the presence of a dc electric field and two ac electric fields was solved, and explicit expressions for the harmonic and combination frequency components of current density were obtained. These expressions were substituted in the general wave equation and the solution was used to investigate two specific phenomena — the nonlinear growth of the second harmonic and sum and difference frequency waves in a plasma, and the magnitude of these frequency components in the wave reflected from a plasma-free space interface when the two incident electromagnetic waves are both traveling perpendicular to the direction of the externally applied dc electric field. A short discussion of the results is also given. (auth)

7256 LOW-FREQUENCY OSCILLATIONS IN A WEAKLY IONIZED PLASMA IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Saito, Susumu; Sato, Noriyoshi; Hatta, Yoshisuke (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 21: 2695-2703(Dec. 1966).

In a hot cathode discharge tube with a coaxial electrode configuration, low frequency oscillations (.3 to 30 kc) propagating in the direction of $E \times B_0$ (E and B_0 are a radial electric and an axial magnetic field, respectively) are observed when B_0 exceeds a critical value corresponding to the condition $\omega_{ce}\tau_{en} \approx O(1)$ and the magnetic field has no effect on ions. The experimental results agree with the results of the analysis based on the two-fluid model in which the effect of the collisions between charged and neutral particles is taken into account. Oscillations are excited by an azimuthal relative velocity between electrons and ions. When the plasma is uniform, the waves are ion–acoustic waves. When the plasma is nonuniform, the wave frequencies are determined by the drift velocity and the ratio of the electron to ion mobilities, if the collision frequency is higher than the oscillation frequency. (auth)

7257 ELECTRON PLASMA OSCILLATIONS EXCITED BY TWO-BEAM INSTABILITY AND NONLINEAR COUPLING BETWEEN THEM. Kawabe, Takaya (Tokyo Univ. of Education). J. Phys. Soc. Jap., 21: 2703-9(Dec. 1966).

Fine structures of electron plasma oscillations were observed using mercury vapor discharge tubes. These fine structures are explained by the dispersion relation for longitudinal oscillations of the electron beam–plasma system. Wave–wave coupling phenomena and a parametric mechanism in a plasma are also found in the generation of higher harmonics of the electron plasma oscillations. (auth)

7258 ON THE INVESTIGATION OF THE X RADIATION FROM A PLASMA BY MEANS OF A SCINTILLATION COUNTER. Demidov, B. A.; Fanchenko, S. D. Zh. Tekh. Fiz., 36: 1166-7 (July 1966). (In Russian).

In recording the x radiation from the decaying plasma in a toroidal machine with a scintillation counter an intense pulse of about 1-μsec duration followed by a series of weak short pulses lasting for some 600 μsec was detected. This effect was observed with CsI, NaI(Te), and stilbene scintillators. Grossman-Doerth and Junker observed a similar effect and ascribed the weak pulses to prolonged emission of soft x rays by the decaying plasma. To test this explanation their experiments were repeated under such conditions that the magnetic field was cut off after about 100 microsec and found that the weak pulses continued unaltered after the field was cut off. It is concluded, therefore, that the weak pulses are not due to soft x radiation from the plasma and suggest that they are due to the slow component of the phosphorescence of the scintillator excited by the very intense initial pulse. (ATD)

7259 INVESTIGATION OF THE CURRENT DENSITY DISTRIBUTION IN THE HOMOPOLAR DEVICE. Drobyshevskii, E. M.; Rozov, S. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 36: 1186-97(July 1966). (In Russian).

The effect of deviations of the magnetic field from uniformity on the distribution of current at the outer electrode of the homopolar device was investigated. The device consists of two coaxial cylindrical electrodes closed at the ends by plane dielectric walls, mounted in an axial magnetic field, and containing plasma in the space bounded by the electrodes and the dielectric end walls. The homopolar device employed in the present experiments was 3.6 cm long with a 9.8-cm-radius outer electrode and a 3.4- or 6.75-cm-radius inner electrode; it was filled with air or hydrogen at from 0.25 to 1.0 mm Hg and was mounted in a 2.5-kOe field. Seven aluminum foil probes were mounted with 0.5-mm gaps between them approximately 1 mm above the inner surface of the outer electrode in order to measure the axial distribution of the current. While the current to one probe was being measured the other probes were grounded to the electrode. The uniformity of the magnetic field was disturbed in an axially symmetric manner by altering the shapes of the pole pieces. In general the current distribution was rather sharply peaked when the inner electrode was negative and rather flat when the inner electrode was positive. Deviations of the magnetic field from uniformity considerably affected the current distribution, and with both polarities the magnetic field configuration near the anode was more significant than that near the cathode. Many current distribution curves are presented and are discussed at some length. Under some conditions current distributions with three maxima were obtained. (ATD)

7260 POSITIVE COLUMN IN AN INCLINED MAGNETIC FIELD. Drobyshevskii, E. M. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 36: 1175-85(July 1966). (In Russian).

The behavior of a plasma confined between infinite plane dielectric walls parallel to the xy plane of a Cartesian coordinate system was investigated in the presence of a uniform electric field parallel to the x axis and a magnetic field that is parallel to the xz plane and is uniform but has different directions in the two regions into which the space occupied by the plasma is separated by a plane parallel to the dielectric walls but not necessarily midway between them. The plasma is assumed to be produced by ionization of neutral molecules by electrons that have been accelerated by the electric field, and recombination is assumed to take place on the dielectric walls, which the electrons and ions reach by ambipolar diffusion. Equations are derived from which the current, electron density, and electron temperature can be calculated as functions of z. These equations were solved numerically for a hydrogen plasma for a number of different values of the pressure, the electric and magnetic field strengths, and the magnetic field inclinations, and the results are tabulated, presented graphically, and discussed at some length. It is shown that small inclinations of the magnetic field to the z axis can have large effects on the current distribution and that a "bent" magnetic field can exert a strong-focusing or defocusing effect on the current, depending on whether its directions are such as to hinder or to aid the ambipolar diffusion of the electrons to the dielectric walls. (ATD)

7261 OBSERVATION OF "CURVED" SPECTRUM LINES IN A PULSED HIGH-FREQUENCY PLASMA. Besshaposhnikov, A. A.; Doroshenko, A. N.; Simonova, N. V.; Chelidze, T. E. Zh. Tekh. Fiz., 36: 1211-14(July 1966). (In Russian).

The rotational velocities and the radial distributions and temperatures of impurity O^+ and Si^{2+} ions in hydrogen plasma filaments were observed spectroscopically. The plasmas were produced by a 1.5-MHz pulsed rotating dipole field in a glass tube 6.5 cm in diameter and 1 meter long containing hydrogen at from 0.02 to 0.25 mm Hg and were confined by a magnetic mirror system with a mirror ratio of 1.57 and a field strength in the uniform field region of 7.2 kOe. Additional stabilization was provided by a cusped octupole field up to 216 Oe corresponding to a diameter of 2 cm. Two conditions of operation were distinguished: "direct rotation", in which the forces on the particles due to interaction of the high-frequency currents in the plasma with the quasistatic field were directed toward the axis of the chamber, and "reverse rotation", in which those forces were directed toward the wall of the chamber. The OII 4649 Å and SiIII 4552 Å lines were observed with a spectrometer having a dispersion of 4 Å/mm and a resolution of 0.1 Å. The lines were very weak and were recorded with the aid of a multistage electron-optical in age converter. The radial distributions of the ion concentrations were determined (in arbitrary units) from the relative intensities of the portions of the lines arising from different parts of the plasma filament, the radial distribution of the rotational velocity was determined from the Doppler shifts of different parts of the lines, and the temperatures of the impurity ions were also determined, presumably from the Doppler broadening. In direct rotation the impurity ion concentration decreased more or less monotonically from the axis to the periphery of the plasma filament; in reverse rotation the ion concentration increased with increasing distance from the axis, passed through a maximum, and then decreased toward the periphery. The rotational velocity was also maximum at some distance from the axis. The rotational velocity was of the order of 10^6 cm/sec at about 1 cm from the axis. The direct rotational velocities decreased with increasing octupole field strength, and the reverse rotational velocities increased with increase of the octupole field strength up to about 144 Oe and decreased with further increase of the octupole field strength. With increasing octupole field strength, the ion temperature decreased in direct rotation and increased in reverse rotation. (ATD)

7262 KINETICS OF THE POSITIVE IONS IN A PENNING DISCHARGE. Smirnitskaya, G. V.; Babertsyan, R. P. (Moscow State Univ.). Zh. Tekh. Fiz., 36: 1217-25(July 1966). (In Russian).

Ion trajectories were calculated in long- and short-anode Penning discharges, using experimentally determined potential distributions. Calculations were performed both for the case of a low-pressure discharge, when space charge may be neglected, and for the case when space charge must be taken into account. For most of the calculations simple quadratic expressions were assumed for the potential as a function of the cylindrical coordinates r and z, and closed expressions were obtained for the trajectories. Numerical calculations based on a slightly more complicated expression for the potential were performed for the case of a ring-anode Penning tube. The following conclusions are drawn: the ions execute complex oscillations about the axis of the discharge or, in case space charge is significant, about the radius of minimum potential, and the number of these oscillations depends on the length of the anode, the conditions of the discharge, and the point of origin of the ion; in the case of a long anode the ions originating on the plane z = a reach the center of the cathode for certain values of a, and reach other parts of the cathode for other values of a; and in the case of a short anode the ions move on logarithmic curves, and only the ions originating on the axis reach the center of the cathode. (ATD)

7263 MEANS FOR MEASURING THE POTENTIAL DISTRIBUTION ALONG AN ELECTRON BEAM. Zinchenko, G. N. Zh. Tekh. Fiz., 36: 1233-8(July 1966). (In Russian).

A method is proposed for deriving the potential distribution along an electron beam moving in an accelerating or a retarding field from measurements of the energy distribution of the residual gas ions produced by the beam. The ions travel along the beam in one direction or the other, depending on the sign of the field, and can be separated from the electrons at the appropriate end of the beam. The energy of a residual gas ion is equal to the potential at its point of origin; the number of ions with a given energy, therefore, is proportional to the length of the segment of the beam throughout which the potential has the corresponding constant value, and the potential gradient along the beam is accordingly inversely proportional to the number of ions per unit energy range at the given energy. The situation is only slightly complicated by the fact that

the ionization cross section depends on the electron energy. An equation is derived with which one can calculate the potential distribution along the electron beam from the energy distribution of the residual gas ions when the energy dependence of the ionization cross section is known, and the sources of error are discussed. The proposed method has the advantage of requiring no field-distorting electrodes. The method was tested by measuring the potential distribution along a 6 cm long beam of initially 1000-eV electrons in an average retarding field of 13.3 V/cm. The residual air pressure was 1.2×10^{-5} mm Hg. The collector electrode had a hole at its center to permit passage of the residual gas ions. Beyond the collector there was a second electrode maintained at a sufficiently high negative potential to assure that the electrons passing through the hole in the collector would be returned to the collector. The second electrode also had a hole at its center, and the ions passing through that hole were collected in a Faraday cup and their energy distribution was determined with the aid of retarding fields. The potential distribution along the beam was altered by means of cylindrical electrodes (drift tubes), and these alterations were clearly reflected in the corresponding energy distributions of the residual gas ions. (ATD)

7264 INTERACTION OF A LIMITED BEAM WITH A BOUNDED PLASMA IN A STRONG MAGNETIC FIELD. Kondratenko, A. N. Zh. Tekh. Fiz., 36: 1317-19(July 1966). (In Russian).

The excitation of axially symmetric waves propagating in the axial direction in a plasma cylinder of radius b in an infinitely strong magnetic field by an electron–ion beam of radius a < b moving along the axis of the plasma cylinder is discussed. A dispersion equation was derived from Maxwell's equations and the kinetic equations for the plasma and the beam. The dispersion equation is presented and its solutions representing high-frequency oscillations and ionic sound are discussed. An expression is derived for the logarithmic increment of the oscillations. The increment depends strongly on the ratio a/b, and when this ratio is small the system can be stable. (ATD)

7265 STABILITY OF AN ARGON PLASMAJET. Adcock, Brian D. (London Univ.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 4: 2249-51(Dec. 1966).

An argon plasma jet was investigated spectroscopically, using a dual grating spectrograph converted to photoelectric operation. The spectral lines due to natural argon at 4300 and 4182 Å were examined. The results are discussed. (M.O.W.)

7266 GUIDED WAVES IN PLASMA MEDIA. Lee, Shung-wu. Urbana, Ill., Univ. of Illinois, 1966. 163p.

Thesis.

Four boundary value problems, all dealing with waves guided in plasma media are investigated: (1) The semi-infinite and finite H-plane bifurcation waveguides filled with an anisotropic incompressible plasma are first considered. The static magnetic field is assumed to be along the edge of the bifurcation. By using the Wiener–Hopf technique, the complete field solutions are obtained for both semi-infinite and finite bifurcations. (2) Next, the same problem is considered except that the plasma medium is isotropic but compressible. Solutions for semi-infinite bifurcation waveguide are also obtained by Wiener–Hopf technique. (3) Thirdly, the wave propagations in an earth–ionosphere waveguide are discussed. The earth is described as a conducting medium with high but finite conductivity; and the ionosphere is approximated by an isotropic compressible plasma. (4) Finally, the current distribution and the input admittance of an infinitely long cylindrical antenna in an anisotropic incompressible plasma are studied. The static magnetic field is assumed to be along the axis of the antenna. Solutions are obtained in integral forms and evaluated for several typical cases. (Dissertation Abstr.)

7267 CYLINDRICAL WAVES IN A COMPRESSIBLE ANISOTROPIC PLASMA WITH SCATTERING APPLICATIONS. Mayhan, Robert Joseph. Lafayette, Ind., Purdue Univ., 1966. 147p.

Thesis.

Solutions are studied for homogeneous boundary value problems involving the interaction of electromagnetic waves with plasma media. The models used to describe the plasma are linearized ones which neglect collisions. In general, compressibility is allowed along with a superimposed static magnetic field which gives the plasma an anisotropic nature. The solution confines itself to general types of cylindrical coordinate systems with the external magnetic field oriented parallel to the z axis. After developing the technique, it is applied to the specific problem of electromagnetic plane wave scattering at an oblique angle from a plasma-coated conducting cylinder. Two cases of polarization are assumed for the incident plane wave, TE and TM, the superposition of which can be used in treating the general case of arbitrary polarization. The numerical evaluation is presented of the back scattering cross section for normal incidence. Only the TE polarization case is evaluated because, when the incident wave is a TM type, the plasma simply behaves as a dispersive dielectric. In addition to evaluating this cross section with the use of the general model of a compressible, anisotropic plasma for the sheath, several simpler models are also used. These are obtained by omitting different terms in the equation of motion for the electrons, and, thus, they are special cases of the general model. The results of these calculations indicate that all the models are identical in the extreme frequency range limits. That is, for $\omega \ll \omega_p$ the plasma behaves as a conductor and for $\omega \gg \omega_p$ the plasma behaves as free space. It is when the frequency of the incident wave is comparable to the plasma frequency that the choice of the model used to describe the plasma is most critical. When the compressible models are used, two different boundary conditions, the rigid boundary and the soft boundary, are used at the plasma–air interface. The results of these calculations are then compared. The results indicate that when the soft boundary is used only a slight degree of coupling between the electromagnetic wave and the pressure wave is obtained. On the other hand, a much greater degree of coupling is obtained with the use of a rigid boundary model. Lastly, in order to take advantage of the numerous data available concerning scattering from isotropic laboratory plasma columns, the cross section for a compressible, isotropic plasma column is found. The theoretical results are then compared with the experimental results. It should be noted that the models used in this thesis are homogeneous while the laboratory plasmas are inhomogeneous. It is found, however, that agreement between the experimental results and the theoretical results is obtained when $\omega < \omega_p$ even though a homogeneous model is used. On the other hand, for $\omega > \omega_p$, it appears that the inhomogeneity of the plasma must be incorporated in the model in order to explain the experimental findings. (Dissertation Abstr.)

7268 EMISSION AND ABSORPTION OF RADIATION BY A HOT PLASMA IN A MAGNETIC FIELD. Tuma, David T. Berkeley, Calif., Univ. of California, 1966. 148p.

Thesis.

The self-consistent distribution of a relativistic electron plasma, in the presence of both collisions and synchrotron radiation damping, is determined. The synchrotron radiation spectrum is then calculated for the self-consistent distribution and compared with the spectrum from a comparable Maxwellian plasma. For the 75-keV plasma, in which radiation damping dominates over diffusion, the radiation intensity is found to decrease from that of the Maxwellian by 15% in the 8th harmonic, in 5 msec., with the difference increasing with the harmonic number. The effect of an electromagnetic wave on the energy of an electron moving in a magnetic mirror field is calculated by simulating the magnetic field, as seen by the particle, with a constant part plus a sinusoidally time-varying part. The energy of the electron is found not to increase indefinitely with time but to oscillate about an average value. The exact equations of motion are then solved numerically and the results are seen to agree reasonably well with the result of Seidl, but not as well with the calculation using the simulated magnetic field. The single particle calculation, which predicts that a few electrons are heated to high energies, while the bulk of the plasma is not heated on the average, agrees qualitatively with some of the cyclotron heating experiments. (Dissertation Abstr.)

7269 MODE ANALYSIS OF ELECTRON BEAMS IN CROSSED FIELDS AND NOISE FIGURES OF CROSSED-FIELD AMPLIFIERS. Sasaki, Akio. Berkeley, Calif., Univ. of California, 1966. 153p.

Thesis.

The mode analysis of an electron beam in crossed fields is established. The wave characteristics, wave patterns and the kinetic powers of beam waves are described. These descriptions provide a physical understanding of the beam waves and make the normalization of mode amplitudes possible. The coupled-mode equations for the electron beam in crossed fields are derived. These equations can be considered to be the basic differential equations of a mode analysis. Using the normal-mode amplitudes and the coupled-mode equations, the following studies were made: (1) Circuit-wave interactions with beam waves. These interactions are described by the kinetic power theorem. One of the results obtained gives the design equation of the fast cyclotron-wave coupler. (2) Boundary conditions for a velocity jump. The effectiveness of a velocity jump for reducing noise quantities is discussed in terms of normal-mode amplitudes. (3) Noise-figure expressions for cyclotron and space-charge-wave amplifiers. The expressions can be applied to either the forward- or backward-wave amplifier. (4) Invariant noise parameters of an electron beam in crossed fields. These parameters are used for the minimum noise-figure expression. (5) Variation of noise in a drift region. This study shows that the diocotron effect does not prevent the drift region from being a linear and lossless region. (6) Minimum noise-figure expression for crossed-field

amplifier. The general noise-figure theory developed by Haus and Robinson for the beam-type amplifier, which has beam waves carrying kinetic power, is extended to the beam-type amplifier in which there exist beam waves carrying no kinetic power. (7) Effect of beam position on noise figure. The analysis of this problem is based on the application of the noise-figure expression in terms of the self- and cross-power density spectra of normal-mode amplitudes and on the extension of the coupled-mode equations by a perturbation method. Finally, ways of designing a low-noise crossed-field amplifier are indicated. (Dissertation Abstr.)

7270 INVESTIGATION OF THE HELIUM HYDRIDE MOLECULAR ION FOR INJECTION INTO THERMONUCLEAR PLASMAS. Wilson, Walter Davis. Berkeley, Calif., Univ. of California, 1966. 60p.

Thesis.

An investigation was made of the helium hydride molecular ion HeH^+, as an injection material for thermonuclear plasmas. Theoretical work based on the reaction $He^+ + H_2^0 \rightarrow HeH^+ + H^0$ has shown that up to 20% of a HeH^+ beam might be dissociated by the confining magnetic field of a high-temperature plasma device, allowing rapid buildup of a plasma via external injection. Recent experimental work has indicated that HeH^+ is formed by the reaction $He^0 + H_2^+ \rightarrow HeH^+ + H^0$; a calculation of HeH^+ beam dissociation based on this reaction is much more difficult. The experiment described here was designed to determine the HeH^+ dissociation by subjecting a HeH^+ beam to electric fields equivalent to $\vec{v} \times \vec{B}$ fields that would be encountered in an injection system. Some results are given. (Dissertation Abstr.)

7271 DEVICE FOR PRODUCING A PULSED CHARGED-PARTICLE BEAM. Takeda, Yasutsugu (to Hitachi, Ltd.). Japanese Patent 1966-1036. Jan. 28, 1966. Filed Sept. 12, 1964.

Apparatus is described which consists of the following: a charged-particle emitter, which gives a charged-particle beam with an annular cross-section; a device for deflecting the beam in the form of a concentric circle; an electrode having an annular hole for the passage of the electron beam; and the accelerating electrodes for acceleration of the beam. (TSS)

7272 PULSED CHARGED-PARTICLES DEVICE. Matsui, Isao (to Hitachi, Ltd.). Japanese Patent 1966-1039. Jan. 28, 1966. Filed Sept. 29, 1964.

An improved pulsed charged-particle device is proposed. To suitably control a charged-particle beam, a dc magnetic field produced by magnetizing coils is usually used. Apparatus is described which consists of the following: an electron gun, a high-frequency source for accelerating the electron beam from the gun, the accelerating tube, and a device, for surrounding the accelerating tube, for focusing the beam in pulses. (TSS)

Production of Plasma

7273 (AD-633730) RETROGRADE ARC AND CATHODE SPOT MOTION IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Giannotta, Salvatore F. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). June 1966. 164p. (GSP/PH-66-6). CFSTI $3.00 cy, $0.65 mn.

Thesis.

Retrograde arc and cathode spot motions on various electrode configurations were examined in a subatmospheric argon environment. Emphasis was placed on the study of semi-stationary arc modes; especially the arc shape, curvature, and arc channel radii, in addition to cathode spot patterns and frequencies of occurrence. Thermionic arcs with tungsten and carbon cathodes were also investigated. Retrograde motion was observed for the first time for arcs which moved completely around fixed electrodes. The highest known arc currents were also achieved for retrograding arcs. Intensely bright, conically shaped protrusions were found on copper plate electrodes which seem to be part of the cathode spots, or possibly the cathode spots themselves, for certain cases. These conical shapes may be extremely high-pressure cathode vapor. Cathode vapor jets were observed to be driven into the amperian direction in all cases in which a magnetic field was present. Measurements of arc channel radii and current densities for copper electrodes at pressures of 6 and 40 mm of mercury are reported. (TAB)

7274 (AD-636956) INVESTIGATION OF PLASMA GENERATORS FOR MICROWAVE DEVICES. Technical Report. Weiner, Maurice; True, Robert M.; Edwards, Edward V. (Army Electronics Command, Fort Monmouth, N. J.). June 1966. 48p. (ECOM-2704). CFSTI $3.00 cy, $0.65 mn.

An experimental study on the Penning Ionization Gauge (PIG) discharge and ion emission from beta-eucryptite was conducted with a view toward the production of plasmas suitable for microwave application. Langmuir probe measurements on the PIG were obtained under various conditions of anode current, magnetic field, gas pressure, and probe position. Radial and longitudinal profiles of electron density, electron temperature, and plasma potential were obtained. Plasma synthesis resulting from separate emitters of electrons and lithium ions from beta-eucryptite was studied. A plasma generator utilizing this concept was designed and fabricated. (auth)

7275 (UCRL-50137) THE ELECTRICAL CONDUCTIVITY PRODUCED IN AIR AND OXYGEN BY AN INTENSE BEAM OF 4-MeV ELECTRONS. Barnes, W. S. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 17, 1966. Contract W-7405-eng-48. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Experiments were performed in which the conductivity produced by the 4-MeV electron beam of the Astron accelerator in air and other gases was measured. From these conductivity measurements estimates were made of the attachment rate A_0 of electrons to oxygen molecules in air and oxygen. The effective values of A_0 found in the experiment varied approximately linearly with the total beam current because of experimental conditions. Calculations performed showed that this variation was at least partially caused by the effect of a cathode fall that occurred during the experiment. Values of A_0 found by extrapolating these linear trends to zero-beam current were compared with those calculated from the results of previous experiments. The values of A_0 found in pure oxygen agreed with those found previously, whereas those found in air were higher than the previous values by a factor of about two. (auth)

7276 (UCRL-Trans-10066) STRUCTURE AND GENERATION OF PLASMA BLOBS IN A COAXIAL INJECTOR WITH IMPROVED ELECTROTECHNICAL PARAMETERS AND VACUUM CONDITIONS. Aretov, G. N.; Pergament, M. I.; Stepanenko, M. M.; Yaroslavskii, A. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Msocow. Institut Atomnoi Energii). Translated by T. Watt for Lawrence Radiation Lab., Univ. of California, Livermore, from report IAE-1017. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $2.60 fs, $1.01 mf.

The results are presented of investigations into the initial stages of the discharge and the motion of plasma blobs in a coaxial injector in an apparatus operated with oil-free evacuation of the vacuum system. On the basis of a comparison between data from various procedures, conclusions are drawn about the motion of a current layer in different modes of operation of the accelerator, about the nature of the spreading of the plasmoids with currents carried away in field-free space, and about the cause of contamination of the plasma. (auth)

7277 PLASMA GENERATION AT SOLID SURFACES IN A GIANT PULSE RUBY LASER BEAM. Kaczmarek, F. (Univ., Poznan, Poland). Acta Phys. Pol., 30: 891-6(Nov. 1966).

Experiments on plasma generation on solid targets with the use of a giant pulse ruby laser beam are described. The laser beam was focused fairly or not at all at different solid surfaces, including very hard materials like ruby or tungsten. The generated plasma was photographed perpendicularly to the beam, i.e., almost parallel to the solid target. The most striking effect was obtained with silver film on a glass substrate. (auth)

7278 PRODUCTION AND DIAGNOSTIC MEASUREMENTS OF KILOVOLT HIGH-DENSITY DEUTERIUM, HELIUM, AND NEON PLASMAS. Beckner, Everet H. (Sandia Lab., Albuquerque, N. Mex.). J. Appl. Phys., 37: 4944-52(Dec. 1966).

Successful production and diagnostic measurements are reported of kilovolt high-density plasmas of deuterium, deuterium–helium mixtures, helium, and neon. Particular attention was given to obtaining a systematic understanding of the electron and ion heating and cooling processes, as well as the attendant equilibration processes. These plasmas typically possessed $1 < T_e < 10$ keV, $2 \times 10^{19} < n_e < 10^{20}$ cm^{-3}, $2 \times 10^{18} < n_i < 10^{20}$ cm^{-3}, copper contamination levels of $n_{Cu} \sim 5 \times 10^{17}$ cm^{-3}, energy densities $\sim 10^5$ J/cm^3, and effective lifetimes ~ 0.5 μsec. Diagnostic measurements were made with absolute time-resolved x-ray and neutron detectors, magnetic and electric probes, and high-speed visible photography. The plasmas were generated in a coaxial discharge tube, with the ions being heated primarily through collapse of the quasicylindrical current sheet, in a manner reminiscent of the linear pinch effect. The electrons rapidly achieved kilovolt temperatures via collisions with the energetic ions; radiation cooling of the electrons was observed, late in time, particularly for those plasmas consisting of high-Z ions. (auth)

7279 PLASMA FORMED BY A LASER PULSE ON A TUNGSTEN TARGET. Ehler, A. W. (Hughes Research Labs., Malibu, Calif.). J. Appl. Phys., 37: 4962-6(Dec. 1966).

Results are presented of an experimental study of the plasma produced by the interaction of the focused light from a Q-switched laser with a tungsten target in a vacuum. The plasma radius, temperature, and radiative properties were measured during the

period of the laser pulse. In addition, the target mass loss and plasma velocity and impulse were observed. Based on these experimental results, a model was developed which provides an energy and power balance for the expanding, radiating plasma. (auth)

7280 SOME CHARACTERISTICS OF LASER-INDUCED AIR SPARKS. Young, M.; Hercher, M.; Wu, Chung-Yiu (Univ. of Rochester, N. Y.). J. Appl. Phys., 37: 4938-40(Dec. 1966).

Some of the optical properties of laser-produced air sparks were measured. The sparks were photographed to determine their structure. The angular distribution of incident laser light scattered by the plasma was found to have a strong peak in the forward direction. The spark spectrum was recorded and used to determine the total energy in the sparks. Application as an intense light source is considered. (auth)

7281 EXPERIMENTAL STUDY OF IONIZATION WAVES. Righetti, G. B. (EURATOM-CNEN, Frascati, Italy). Nuovo Cimento (10), 46B: 163-71(Dec. 11, 1966).

The study of the propagation of externally excited density waves along the positive column of a low pressure arc is reported. Within the range of experimental values two modes are found for hydrogen and only one is found for nitrogen. The propagation and dispersion relation do not depend on the excitation mechanism used. Experimental results for nitrogen generally are in good agreement with predictions obtained from Pekarek's theory for density waves, but some important discrepancies do exist. Further study and more sophisticated experimental techniques would be necessary to clarify these problems. (auth)

7282 NON-EQUILIBRIUM IONIZATION GROWTH IN MOLECULAR HYDROGEN. Haydon, S. C.; Stock, H. M. P. (Univ. of New England, Armidale, Australia). Austral. J. Phys., 19: 795-803(Dec. 1966).

A thin-film cathode is used in an examination of the spatial growth of ionization in molecular hydrogen at high values of the parameter E/p (E is the electric field strength in volts/cm; p is the gas pressure in torr at 0°C). Particular attention is given to the region of small gap separations d where nonequilibrium ionization growth occurs. The effect of nonuniformity of the electric field in this region due to anode perforations is demonstrated and the consequences of including ionization current measurements at small values of d in analyses of growth of current measurements are discussed. The variation of the "effective" Townsend coefficient a/p with E/p in uniform field conditions is obtained for values of E/p up to 1000 V cm^{-1} $torr^{-1}$. (auth)

7283 NEW METHOD FOR DETERMINING THE POTENTIAL DISTRIBUTION IN A PENNING DISCHARGE. Reikhrudel, E. M.; Smirnitskaya, G. V.; Babertsyan, R. P. (Moscow State Univ.). Zh. Tekh. Fiz., 36: 1226-32(July 1966). (In Russian).

A new technique is described for determining the potential distribution in a Penning discharge. The ion-kinetic method is based on the fact that ions originating on certain planes perpendicular to the axis of a Penning discharge reach the center of the plane cathode at angles depending on their radii of origin. To measure the radial distribution of potential in the Penning discharge one need merely measure the energies of the ions issuing in different directions from a hole in the center of the cathode and employ the appropriate equations, which are presented but not derived. The most energetic ions issuing in a given direction originate on the central plane of the discharge tube, and from the energies of the most energetic ions issuing in different directions one can determine the radial distribution of potential on that plane. Advantages of the ion-kinetic method are that it involves no distortion of the field within the Penning tube and that it can be employed over the wide pressure range from 10^{-3} to 10^{-11} mm Hg. The ion-kinetic method was employed to measure radial potential distributions on the central plane of a Penning tube having a cylindrical anode 1 cm long and 4 cm in diameter and plane cathode 6 cm away. Some 30 potential curves, recorded at different pressures, magnetic field strengths, and discharge currents are presented and discussed in some detail. It is concluded that increasing the magnetic field strength hinders the escape of electrons to the anode and increases the negative space charge, and that increasing the pressure facilitates escape of electrons to the anode and reduces the negative space charge. At the highest pressures (about 10^{-3} mm Hg) the space charge was neutralized and the potential distribution was similar to that in a glow discharge. (ATD)

7284 INVESTIGATION OF WAVE PROCESSES IN A CONICAL-ELECTRODE SHOCK TUBE. Grechikhin, L. I.; Min'ko, L. Ya. Zh. Tekh. Fiz., 36: 1202-6(July 1966). (In Russian).

It was earlier found that under certain conditions supersonic plasma streams can be formed in a shock tube, that these streams have a complex structure due to wave processes, and that they can affect (and in particular, can accelerate) the motion of the luminous front. Further experiments on plasma streams in a shock tube are reported here. The plasmas were produced by discharge of a capacitor between a conical electrode and an internal cylindrical electrode. The supersonic streams arose from expansion of the plasmas issuing from the 4-cm-diameter conical electrode into the 6-cm-diameter glass drift tube. The plasmas were observed by high speed cinematography and by streak photography, with particular attention to behavior of the plasmas on reflection at the far end of the tube. The velocity of the luminous front produced by a 2-kV discharge increased from about 6 km/sec, when it issued from the electrode, to 14 km/sec, after it had traveled some 45 cm. The velocity of the luminous front produced by a 4-kV discharge was somewhat higher, but its average acceleration was about the same as that of the luminous front produced by the lower energy discharge. The initial motions of those two fronts were somewhat different, however. A streak photograph is presented that clearly shows a banded structure of the luminous region. Cinematograms and a streak photograph are also presented that illustrate the complex phenomena taking place in the reflection zone. It is concluded that under certain conditions supersonic plasma streams with a complex wave structure can be produced in a shock tube, that the wave processes accelerate the motion of the luminous front, that the supersonic stream interacts with the reflected luminous front and distorts it, and that the plasma stream remains supersonic in the reflection zone and has a complex wave structure that affects the character of the interaction with the obstacle. (ATD)

7285 OSCILLOGRAPHIC INVESTIGATION OF HIGH-PRESSURE PULSED DISCHARGES IN HELIUM. Romanenko, I. N. Zh. Tekh. Fiz., 36: 1171-4(July 1966). (In Russian).

An investigation was made of 35-kV discharges of a 3-μF capacitor across gaps ranging in length at least from 2 to 10 mm in helium at pressures up to 60 atm. The inductance of the discharge circuit was 4.7 μH and the maximum current was 29 kA. From oscillograph records of the current and voltage, the resistance of the gap and the power expended in it were determined. The inductive component of the current across the gap was compensated on the oscillograms with the aid of a network that involved a voltage divider but is not described in further detail. The compensating network was adjusted to compensate the discharge potential across a metallic cylinder bridging the gap and having a diameter equal to the maximum diameter of the spark channel, as determined beforehand by high-speed photography. An accuracy of 10 to 15% is claimed for the measurements. The variations with time, gap length, and helium pressure of the gap resistance and the power expended are presented graphically and are discussed. The gap resistance reached its minimum value after the current had passed through its maximum. The power developed in the spark, the energy expended during the first cycle of the discharge, and the ratio of that energy to the total discharge energy increased with increasing helium pressure, and that increase was the more rapid, the longer the gap. The powers developed in the discharges ranged between 1 and 10 MW. (ATD)

7286 INVESTIGATION OF A HOLLOW-CATHODE DISCHARGE. II. Borodin, V. S.; Kagan, Yu. M.; Lyagushchenko, R. I. Zh. Tekh. Fiz., 36: 1198-1201(July 1966). (In Russian).

Previous work showed that the electron energy distribution in a hollow cathode differs from that in a positive column in that its maximum occurs at a lower electron energy and it falls off less rapidly with increasing energy. Probe measurements in a hollow cathode 10 cm long and 2 cm in diameter have now shown, in agreement with other findings, that the electric field within a hollow cathode is very weak. Measurements of the electron energy distribution within the hollow cathode were extended beyond the previous upper limit of 40 eV to some hundreds of eV with the aid of a two-grid electrostatic analyzer. It is found that the distribution function has a second maximum at an electron energy close to the energy of the cathode drop (several hundred eV in the present experiments). A simple kinetic calculation in which excitation and stepwise ionization were neglected and it was assumed that electrons of energy corresponding to the cathode drop appear at a uniform rate throughout the volume within the hollow cathode gave a theoretical electron energy distribution that is in qualitative agreement with the distribution observed near the wall of the cathode. The electron energy distribution observed at the center of the cathode differed from the theoretical distribution in having a sharper maximum and fewer fast electrons. (ATD)

7287 MOVING STRIATIONS IN THE ARGON POSITIVE COLUMN. I. THEORY. Gentle, Kenneth W. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 9: 2203-11(Nov. 1966).

The equations governing the plasma in the positive column of a dc discharge are analyzed for wavelike perturbations about

equilibrium. Conservation-of-number equations are used for ions and metastables; the Boltzmann equation is used for electrons. The tail of the distribution determines the important source terms in the number equations. The equations are solved numerically for several cases in argon to determine the properties of the waves. Growing waves that propagate from anode to cathode are found for densities below a critical value, corresponding to the Pupp limit. The group velocity is in the opposite direction. (auth)

7288 MOVING STRIATIONS IN THE ARGON POSITIVE COLUMN. II. EXPERIMENTS. Gentle, Kenneth W. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 9: 2212-18(Nov. 1966).

A dc argon discharge is operated with gas flowing opposite to the phase velocity of naturally occurring striations. For a range of gas flows, the striations appear stationary in the laboratory frame. Identifying gas velocity with phase velocity and measuring the wavelength determines the striation dispersion relation in the range of stationarity. Observations were made in a tube of 1-cm diameter, at 5- to 20-torr pressures and 30- to 300-mA currents. The experimental results for a pressure of 10 torr are compared with the theoretical calculations. Satisfactory agreement is found, especially considering that large-amplitude waves are compared with a linear model. Microwave measurements of the electron temperature and density variations in the striations are presented. (auth)

7289 GLOW DISCHARGE AND AN INTRODUCTION TO PLASMA PHYSICS. Llewellyn-Jones, F. Methuen's Monographs on Physical Subjects. New York, John Wiley and Sons, Inc., 1966. 220p. $5.00.

Various theoretical discussions are presented for the following: glow discharge phenomena, collisional processes and transport, ionization and de-ionization processes, the discharge passes (transition to the glow), electrode phenomena, the positive column or uniform plasma, applications in electronics and plasma physics, and vacuum systems. (M.O.W.)

7290 HIGH-TEMPERATURE PLASMA GENERATOR. Matsuda, Jinsaku (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1965-23560. Oct. 16, 1965. Filed Feb. 8, 1964.

A new high-temperature plasma generator is proposed for use in thermonuclear reaction experiments. The generator employing an improved spark-gas technique is very simple and does not require the use of a complex thyratron pulse generator and a delay circuit. (NSA of Japan)

Stability of Plasma

Refer also to abstract 7214.

7291 (CEA-R-3089) STABILITE ELECTROSTATIQUE DES PLASMAS DE LONGUEUR FINIE. INSTABILITES EN "FLUTES". (Electrostatic Stability of Plasmas of Finite Length. "Flute" Instabilities). Cotsaftis, Michel (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct. 1966. 24p. (ERU 3139.f). Dep. mn.

The full dispersion relation is written for "flute" instabilities, in the simplest case of slab geometry with an equilibrium state taking into account: the finite length (along z direction) of the plasma, and any cold plasma between this plasma and conducting plates at a finite distance of the symmetry plane of the system. The exact equations of the stability limit are deduced with the usual physical hypothesis of finite Larmor radius and zero gradient, but with the gravity term, which write in general as a set of curves relating two dimensionless parameters $\bar{\epsilon}_i$ and K, depending on another dimensionless parameter A, the expressions all of which are given. In this three-parameters set of curves is contained all the information needed for the study of the electrostatic stability of a system. With respect to previous work of Babikin destabilizing terms are introduced which have been neglected though they can have important effects. It is shown, in particular, that electrostatic instabilities can exist even in magnetic wells, and it is verified that with the commonly used hypothesis there is no instability. Furthermore, it is found that transforming a magnetic bottle or a well into a sufficiently "deep" well, by adding a multipolar field, for instance, does not lead always to stabilization. (M.O.W.)

7292 (MATT-Trans-31) KINETIC THEORY OF DRIFT-DISSIPATIVE PLASMA INSTABILITIES. Rukhadze, A. A.; Silin, V. P. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated for Plasma Physics Lab., Princeton Univ., N. J., from the Russian. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $3.60 fs, $1.34 mf.

An analysis was made of almost all possible spectra of unstable oscillations in an inhomogeneous plasma, retained by a strong magnetic field, with the exception of long-wave oscillations, for which the conditions $k_z\rho_i \ll 1$ and $\nu_e \gg (\omega, k_z v_{Te})$ are fulfilled, but $\nu_i \gg (\omega, k_z v_{Ti})$. For convenience, the results of this analysis of oscillation spectra are presented in a general table, where the frequency spectra of unstable oscillations are shown, along with their growth increments, the role of electron and ion collisions in the development of the instability and the conditions for its stabilization by magnetic field line of force crossing. (M.O.W.)

7293 (UCRL-Trans-10067) INVESTIGATION OF CURRENT BEAM INSTABILITY IN AN INHOMOGENEOUS PLASMA. Buchel'nikova, N. S.; Salimov, R. A.; Eydel'man, Yu. I. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by T. Watt for Lawrence Radiation Lab., Univ. of California, Livermore, from a Preprint. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $3.60 fs, $1.25 mf.

Instability developing in a nonuniform (with respect to density) highly ionized potassium plasma when a current is passed through it was studied. Experiments were conducted with magnetic fields of 400 to 2000 Oe and plasma densities of 10^9 to 10^{10} cm^{-3}. The plasma was collisionless. In accordance with what has been shown earlier, "universal" instability, appearing as the excitation of drift waves, occurs in the absence of current flow. In the presence of current flow two oscillatory branches are excited, one representing drift waves and the other ion-acoustic waves. For the first branch the frequency of the oscillations is inversely proportional to the magnetic field. The waves have an azimuthal component; the azimuthal phase velocities of all the harmonics are the same. For the second branch, the oscillation frequency is independent of the magnetic field and varies inversely with the length of the system. The phase velocity of the longitudinal component practically coincides with the ion-acoustic velocity. The critical velocity of the drift of electrons relative to ions, at which ion-acoustic waves are excited, $\sim 2 \times 10^6$ cm/sec, is an order of magnitude lower than that computed for a uniform, almost isothermal plasma. During the excitation of current beam instability the diffusion coefficient increases by a factor of 1.5 to 2.5; diffusion begins to increase simultaneously with the amplitude of the oscillations. (auth)

7294 USE OF THE GALERKIN METHOD FOR SOLVING PROBLEMS ON THE STABILITY OF AN INHOMOGENEOUS PLASMA. Dnestrovskii, Yu. N.; Kostomarov, D. P. pp 60-7 of Chislennyye Metody Resheniya Zadach Matematicheskoy Fiziki, 1966. Moscow. (In Russian).

The Galerkin method is used to solve the problem of the stability of an inhomogeneous plasma in relation to the drift oscillations of an ordinary wave propagating across an external magnetic field. Used as comparison functions are eigenfunctions of a Sturm-Liouville problem. The above method is used to investigate the instability increments of the oscillations under consideration for various plasma parameters. (auth)

7295 TRANSVERSE WAVE INSTABILITIES IN ANISOTROPIC HYDROGEN PLASMAS. Noerdlinger, Peter D. (Univ. of Chicago). Phys. Fluids, 9: 2224-30(Nov. 1966).

In the presence of a uniform magnetic field B_0, an extensive family of uniform, collisionless hydrogen plasmas is examined for instability with respect to transverse waves. Only waves propagating along B_0 are considered. The initial pressure along B_0 is $p_{||}$ and that perpendicular to B_0 is $p_\perp$, with $p_\perp \neq p_{||}$. For $p_{||} > p_\perp$, the unstable electron waves are almost identical to those in a plasma with immobile ions, and there is an unstable family of ion waves similar to those that would be found if the electrons were taken to be an immobile background. The ion waves are confined to a small band of wave numbers as B_0 is made small, however, and they disappear when $B_0 = 0$. For $p_{||} > p_\perp$, the plasma is found to be unstable if $p_{||} - p_\perp > B_0^2/2\pi$. When this criterion is satisfied, growing waves exist with growth rates generally of the order of a few tenths of the ion gyrofrequency. The classical firehose instability criterion is $p_{||} - p_\perp > B_0^2/4\pi$, which represents a domain of instability twice as large as that found here. The classical result was obtained in the extreme low-frequency long-wavelength limit, where the present treatment runs into difficulty from relativistic effects. Hence it is expected that for plasmas satisfying the old instability criterion but not the one found here, there exist unstable waves with growth rate very much less than the ion gyrofrequency. The growth rates and other properties of the fastest growing of these waves could only be found in a relativistic treatment. (auth)

7296 FINITE β EFFECTS IN A WEAKLY UNSTABLE PLASMA. Pearlstein, L. D.; Krall, Nicholas A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 9: 2231-8(Nov. 1966).

The effect of finite plasma pressure (β) on the interchange mode is calculated in the finite Larmor radius limit. The method

follows earlier zero β calculations of Rosenbluth and Simon, expanding the Vlasov equation with the ion Larmor radius a_i considered small compared with the plasma radius L. The plasma pressure is taken to be zero order in a_i/L. A differential equation is obtained for the stability properties of systems with arbitrary radial dependence of density, electric field, magnetic field, and β. Several simple examples show that increasing β moves marginally flute unstable systems to stability, if the change in β does not include violent changes in the density and field profiles. (auth)

7297 INTERCHANGE INSTABILITY IN A HOT-ELECTRON PLASMA. Kuckes, A. F. (Princeton Univ., N. J.). Phys. Fluids, 9: 2239-43(Nov. 1966). (MATT-444).

A recent experiment by Ferrari and Kuckes on the containment of a three-component plasma consisting of hot electrons, cold electrons, and cold ions in a simple magnetic mirror device is considered. The conditions for "gravity-driven" instability in such a plasma are derived and found to quantitatively coincide with the experiment. The lack of stabilization by a conducting end plate observed is found to be in accord with the theory. The total ejection of plasma across the magnetic field lines observed can be understood by considering the generation of ambipolar potentials and currents. (auth)

7298 THEORY OF PARAMETRIC COUPLING IN PLASMAS. Lee, Y. C. (Bell Telephone Labs., Whippany, N. J.); Su, C. H. Phys. Rev., 152: 129-35(Dec. 2, 1966).

Based on a simple fluid approach, the theory of the instability due to the nonlinear coupling of an electron plasma oscillation and an ion acoustic oscillation to a driving transverse field is worked out and extended to the case in which the driving field is a longitudinal field. It is shown that the effects of transverse and longitudinal driving fields on the instability are the same in the limit of long wavelength as would be expected physically. In addition, the effect of an electron drift velocity on the nonlinearity-induced instability mentioned above is also examined. It is found that the electron plasma oscillation can be greatly enhanced when the drift velocity approaches the ion wave velocity. Derivation of the above results by the Vlasov equation is indicated in an appendix. (auth)

7299 INSTABILITY OF A HIGH-FREQUENCY DISCHARGE IN A MAGNETIC FIELD. Pinskii, Ya. M. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 36: 1168-70(July 1966). (In Russian).

It was shown in an earlier paper that a sufficiently low-pressure plasma in parallel static magnetic and high-frequency electric fields can be unstable. These calculations are generalized to the case of an arbitrary angle between the directions of the static magnetic and high-frequency electric fields, and the more general stability condition is derived. The notation and results of the previous paper are used. It is found that the instability of the plasma persists to much higher values of the electron collision frequency when the electric and magnetic fields are perpendicular than when they are parallel. (ATD)

Thermonuclear Processes

Refer to abstract 6846.

Shielding

Refer also to abstract 7661.

7300 (AD-635279) PROBLEMS OF DOSIMETRY AND RADIATION SHIELDING (SELECTED ARTICLES). (Foreign Technology Div., Wright-Patterson AFB, Ohio). Feb. 16, 1966. 32p. (FTD-MT-65-30; TT-66-61689). CFSTI $4.00 cy, $0.50 mn.

Experimental investigations were made of distribution functions of point monodirected gamma sources with initial gamma-quanta energy of 0.661 and 1.25 MeV in concrete, Al, Fe, and Pb. The spectral-angular distribution of gamma-radiation from the surface of a half-medium with evenly distributed isotropic sources is described. (S.F.L.)

7301 (ORNL-RSIC-5(Rev.1)) BIBLIOGRAPHY, SUBJECT INDEX, AND AUTHOR INDEX OF THE LITERATURE EXAMINED BY THE RADIATION SHIELDING INFORMATION CENTER. Penny, S. K.; Trubey, D. K.; Gurney, J. (Oak Ridge National Lab., Tenn.). May 1966. Contract W-7405-eng-26. 591p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

This is the fourth cumulative edit of the literature concerned with nuclear reactors, nuclear weapons, and radioisotopes selected by the Radiation Shielding Information Center. (M.H.R.)

7302 (ORNL-TM-1604) REPORT OF A MEETING OF A WORKING COMMITTE ON SHIELDING CONVENTIONS [HELD AT OAK RIDGE NATIONAL LABORATORY, APRIL 14-15, 1966]. Clark, F. H. (ed.) (Oak Ridge National Lab., Tenn.). Nov. 8, 1966. Contract W-7405-eng-26. 32p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The main theme of the meeting was "how to report or characterize a radiation field." Main emphasis was placed on problems where the source a reactor, weapon, or decaying radioactive nuclide. The need for standardization in the field of shielding conventions and the difficulties in having standards adhered to are discussed. Plans for improving communications between groups concerned with shielding conventions were outlined. (M.H.R.)

7303 BUILDUP FACTORS FOR POINT MONOENERGETIC LOW-ENERGY PHOTON SOURCES IN AIR. Krumbein, A. D.; Cohen, M. O.; Ross, R. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 9: 342(Oct.-Nov. 1966).

7304 BUILDUP FACTOR IN AIR AT SHORT DISTANCES FROM A POINT GAMMA SOURCE ON THE INTERFACE BETWEEN AIR AND A PERFECT ABSORBER. Chilton, A. B.; Fu, C. Y. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc., 9: 343(Oct.-Nov. 1966).

7305 THE EFFECT OF CUTOFF ENERGY ON MONTE CARLO CALCULATED GAMMA-RAY DOSE RATES IN AIR. Marshall, J. D.; Wells, M. B. (Radiation Research Associates, Inc., Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 9: 343-4(Oct.-Nov. 1966).

7306 TESTING OF ELECTRON SHIELDS FOR SPACECRAFT. Stromquist, Walter K. (Aerospace Corp., San Bernardino, Calif.). Trans. Amer. Nucl. Soc., 9: 333-4(Oct.-Nov. 1966).

7307 EFFECTS OF NEUTRON-ENERGY SPECTRUM IN AIR ON THE NEUTRON-INDUCED DOSE IN CONCRETE UNDERGROUND STRUCTURES. Mooney, L. G.; Wells, M. B. (Radiation Research Associates, Inc., Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 9: 344-5(Oct.-Nov. 1966).

7308 COMPARISONS OF CALCULATED AND MEASURED NEUTRON DOSE RATES INSIDE STEEL COMPARTMENTS EXPOSED TO THE RADIATION FIELD OF A REACTOR. Long, J. J.; Wells, M. B. (Radiation Research Associates, Inc., Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 9: 345(Oct.-Nov. 1966).

7309 INFINITE-FIELD GAMMA DOSE RATES IN STRUCTURES FROM FINITE-FIELD EXPERIMENTS. Kaplan, Arthur L.; Koepp-Baker, Nicholas B. (Technical Operations Research, Burlington, Mass.). Trans. Amer. Nucl. Soc., 9: 345-6(Oct.-Nov. 1966).

7310 SOLUTION OF THE CEILING-SHINE PROBLEM IN STRUCTURE SHIELDING DESIGN AND ANALYSIS. Rubin, R. M.; Baran, J. A.; Urban, W. T.; Iotti, R. C.; Faw, R. E.; Kimel, W. R. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc., 9: 346-7(Oct.-Nov. 1966).

7311 ANALYSIS OF A SHIELDING EXPERIMENT PERFORMED IN A REAL FALLOUT FIELD. French, R. L.; Price, J. H.; Tompkins, K. W. (Radiation Research Associates, Inc., Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 9: 347-8(Oct.-Nov. 1966).

7312 EXPERIMENTAL DETERMINATION OF DIFFERENTIAL ENERGY AND ANGLE SPECTRA FOR ^{137}Cs GAMMA RAYS IN WATER. Alberg, Mary; O'Brien, Keran; McLaughlin, James (Atomic Energy Commission, New York). Trans. Amer. Nucl. Soc., 9: 349(Oct.-Nov. 1966).

7313 EFFECTIVE GAMMA-RAY SPECTRA FOR THERMAL-NEUTRON CAPTURE AND PROMPT FISSION. Dudziak, Donald J. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 349-50(Oct.-Nov. 1966).

7314 ACCURACY AND PRECISION OF SPECTRAL MEASUREMENTS. Baran, J. A.; Urban, W. T.; Faw, R. E.; Mingle, J. O.; Copic, M.; Kimel, W. R. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc., 9: 351(Oct.-Nov. 1966).

7315 TIME-OF-FLIGHT MEASUREMENTS OF THE NEUTRON ANGULAR-FLUX SPECTRUM IN GRAPHITE. Profio, A. E.; Antunez, H. M.; Russell, J. L. Jr. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 351-2(Oct.-Nov. 1966).

7316 NEUTRON ATTENUATION IN LITHIUM-HYDRIDE HEAVY-METAL SHIELDS. Thiele, A. W.; Golliher, K. G.; Payne, J. W. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 352-3(Oct.-Nov. 1966).

7317 DIRECT MEASUREMENT OF FAST-NEUTRON SPECTRA AND THE NEUTRON DIFFERENTIAL-DOSE ALBEDO FOR CONCRETE WITH THE NE-213 NEUTRON SPECTROMETER. Habiger, K. E. (Oak Ridge National Lab., Tenn.); Kapitzke, J. A.; Kimel, W. R.; Meyer, W. Trans. Amer. Nucl. Soc., 9: 353(Oct.-Nov. 1966).

7318 EXPERIMENTAL MEASUREMENT OF THE STRAIGHT-AHEAD APPROXIMATION. Haffner, J. W.; Beever, E. R.; Rusling, D. H. (North American Aviation, Inc., Downey, Calif.). Trans. Amer. Nucl. Soc., 9: 335(Oct.-Nov. 1966).

7319 TRACK-LENGTH STRETCHING AS A MONTE CARLO BIASING TECHNIQUE IN DEEP-PENETRATION CALCULATIONS. Karcher, R. H.; Erdmann, R. C.; Baldonado, O. C. (Holmes and Narver, Inc., Los Angeles). Trans. Amer. Nucl. Soc., 9: 365 (Oct.-Nov. 1966).

7320 APPLICATION OF DISCRETE-ORDINATES TRANSPORT THEORY TO DEEP-PENETRATION FAST-NEUTRON-DOSE CALCULATIONS IN WATER. Mynatt, F. R.; Greene, N. M.; Engle, W. W. Jr. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 9: 366-8(Oct.-Nov. 1966).

7321 CALCULATIONS USING THE ALBEDO CONCEPT OF THE SUBCADMIUM FLUX ALONG THE CENTER LINES OF ONE-, TWO-, AND THREE-LEGGED SQUARE CONCRETE DUCTS ARISING FROM INCIDENT SUB-CADMIUM NEUTRONS: COMPARISON WITH EXPERIMENT. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 368(Oct.-Nov. 1966).

7322 MODIFIED EXPOSURE ALBEDO FORMULA FOR GAMMA RAYS REFLECTED FROM CONCRETE. Chilton, A. B. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc., 9: 369 (Oct.-Nov. 1966).

7323 SEMI-ANALYTICAL MODEL FOR MATHEMATICAL SIMULATION OF GAMMA-RAY TRANSPORT THROUGH SHIELDING. Biro, George G. (Gibbs and Hill, Inc., New York); Lidofsky, Leon J. Trans. Amer. Nucl. Soc., 9: 369-70(Oct.-Nov. 1966).

7324 ENERGY BUILDUP FACTORS IN WATER FOR VERY DEEP PENETRATIONS. Lois, L. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 370-1 (Oct.-Nov. 1966).

7325 HIGH-ENERGY ACCELERATOR SHIELD LEAKAGE NEUTRON SPECTRA. O'Brien, Keran; Sanna, Robert; Alberg, Mary; McLaughlin, James E. (Atomic Energy Commission, New York). Trans. Amer. Nucl. Soc., 9: 354-5(Oct.-Nov. 1966).

7326 FAST-NEUTRON COLLIMATOR STUDIES. Straker, E. A.; Emmett, M. B. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 355-6(Oct.-Nov. 1966).

7327 SOURCE-SEPARATION INVESTIGATION OF THERMAL NEUTRONS IN DUCTED SHIELDS. Channon, F. R. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 9: 356(Oct.-Nov. 1966).

7328 SHIELD-MATERIALS COMPARISON AND OPTIMIZATION. Ricks, L. O.; Disney, R. K. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 365-6(Oct.-Nov. 1966).

7329 GAMMA-RAY SPECTRA OF THICK SOURCES. Mohindra, Virender Kumar. Toronto, Univ. of Toronto, 1964. Thesis.

The changes introduced into the gamma ray scintillation spectra obtained from "point" sources imbedded at different depths in the water medium were studied. Gamma ray energies used were in the range 0.28 to 1.36 MeV. The relative variations in the valley-to-peak ratio and apparent resolution of the photopeak were used as measures of the changes of spectrum shape. The use of the valley-to-peak ratio as a measure had two advantages over the use of the resolution: the changes in the valley-to-peak ratio were larger than corresponding changes in the resolution and the valley-to-peak ratio gave a linear increase with increasing depth of the water medium above the source. The experimental work was performed for two different cases. Firstly, the changes in the gamma ray spectra were studied at a fixed source-detector geometry and only the depth of water above the source was varied. Secondly, the thickness of the water medium in the container was kept constant, and the distance of the source below the surface of water was changed. The second case corresponds to the presence of a localized source at a certain depth in a human body. A qualitative explanation was given to explain the general nature of the curves and to show the relation between the above mentioned changes and the depth of the source in the water medium. As an application of the results to human bodies a technique was developed to find body thickness using a NaI(Tl) crystal and a point source placed immediately beneath a subject. The above application closely resembles the case where the source is inside the body. The depths of the sources as measured by the method are in good agreement with the directly measured depths. (Dissertation Abstr.)

Solid-State Physics

Refer also to abstracts 6370, 6772, 6822, 7160, 7394, 7395, 7645, and 7694.

7330 (AD-635433) ELECTROLUMINESCENCE AND BAND GAP IN ANTHRACENE. Sano, M.; Pope, M.; Kallmann, H. (New York Univ., N. Y. Radiation and Solid State Lab.). 1966. 5p. CFSTI $1.00 cy, $0.50 mn.

If anthracene is exposed to high energy radiation, scintillation is observed, and the fluorescence spectrum is identical to that of the uv stimulated material. This emission is a result of the radiative decay of the first excited singlet state of anthracene. The question arises whether the recombination of holes and electrons emits light, and even more significant, whether this recombination in their lowest conduction states emit light. Evidence is reported that holes and electrons in their lowest conduction states recombine to produce the first excited singlet state, which then emits the characteristic fluorescence. An important conclusion is that the band gap for electronic conductivity in anthracene is greater than 3.1 eV. (auth)

7331 (COO-1198-401) FREQUENCY DEPENDENCE OF DISLOCATION DAMPING IN SINGLE CRYSTAL COPPER. Heiple, Clinton Rie (Illinois Univ., Urabana, Dept. of Mining, Metallurgy, and Petroleum Engineering). Oct. 31, 1966. Contract AT(11-1)-1198. 72p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The frequency dependence of the amplitude-dependent and amplitude-independent dislocation damping was measured on the same high-purity Cu single crystal in both the kilocycle and megacycle frequency ranges. The dislocation contribution to the elastic modulus was also measured in the kilocycle range. The results are discussed in terms of a theoretical calculation that treats the dislocation as a pinned elastic string that experiences a viscous drag proportional to its velocity. The kilocycle dislocation damping exhibited an approximately linear frequency dependence; however, a somewhat better fit to the data can be made with a relation of the form $\Delta = \alpha\omega^{-1} + \beta\omega$. It is proposed that the term $\alpha\omega^{-1}$ is a contribution from the high-frequency side of a low-frequency maximum. The dislocation damping in the megacycle range was proportional to ω^{-1}. The kilocycle and megacycle data are consistent with a curve of the form $\Delta = K\omega\tau/(1 + \omega^2\tau^2)$ as predicted by the string model. The maximum is at 1.7 Mc. The dislocation density is calculated to be 2.3×10^6 cm^{-2} and the average loop length to be 5.1×10^{-4} cm, assuming an exponential loop length distribution. The modulus defect was found to be independent of frequency except for a small rise with decreasing frequency below 30 kc. The amplitude-dependent internal friction of the specimen in the kilocycle range was found to be frequency-dependent in the annealed state and to be frequency-independent in the neutron-irradiated state. The strain amplitude above which the specimen exhibited amplitude dependence was observed to increase with frequency in the kilocycle range. (auth)

7332 (INR-744/II/PS) APPLICATION OF PULSED NEUTRON SOURCES TO STRUCTURE AND LATTICE DYNAMICS STUDIES OF SOLIDS. Buras, Bronislaw (Institute of Nuclear Research, Swierk (Poland). Warsaw Univ. (Poland). Inst. of Experimental Physics). Aug. 1966. 23p. Dep. mn.

The actual and potential applications of pulsed neutron sources to studies of structure and lattice dynamics of solids are discussed. A brief description of the time-of-flight (TOF) method for structure analysis is given, some typical results obtained both for powders and single crystals are presented, and a comparison between the conventional and TOF methods is made. Special emphasis is put on resolution and intensity (time of exposure) problems. In particular it is shown that for magnetic structure analysis and small lattice distortions studies the TOF method used with repetitively pulsed reactors is preferable. Special features of the TOF method and their nonconventional applications to structure studies are discussed, e.g. studies of the influence of very high repetitively pulsed external fields on structure and studies of transient phenomena. A new modification of the TOF method for lattice dynamics research is briefly presented. Special features of the TOF method and their nonconventional applications to lattice dynamics studies are mentioned. A method for simultaneous structure and lattice dynamics studies is presented. This may be useful in studies of the relation between the structure of a solid and its lattice dynamics, especially in studies of phase transitions and the influence of external fields both on structure and lattice dynamics. The final conclusion, that high-intensity pulsed neutron sources open a new promising area of research on structure and lattice dynamics of solids, is emphasized. (auth)

7333 (LA-3615) TABLES FOR THE RAPID EVALUATION OF THE DEBYE CHARACTERISTIC TEMPERATURE OF CUBIC

CRYSTALS FROM ELASTIC CONSTANTS. Overton, W. C. Jr.; Schuch, A. F. (Los Alamos Scientific Lab., N. Mex.). Oct. 31, 1966. Contract W-7405-eng-36. 58p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Extensive numerical calculations have been carried out on the CDC 6600 computer to obtain accurate tables of a function $G(S,\tau)$. From these tables the Debye characteristic temperature θ of any cubic crystal can be calculated rapidly and with great accuracy. If the cubic crystal elastic constants are known then the parameters $S = (c_{11} - c_{44})/(c_{12} + c_{44})$ and $\tau = (c_{12} + c_{44})/c_{44}$ can be evaluated. The tables range from $S = 0.04$ to 4.51 (interval 0.03) and $\tau = 1.00$ to 4.80 (interval 0.05), which will span (S,τ) for practically all cubic crystals for which c_{ij}'s are known. All table entries are accurate to ±1 in the sixth decimal. It is possible to compute θ with an absolute accuracy of better than ±1 in 10^5 by two-dimensional interpolation. Usually, linear two-dimensional interpolation gives this accuracy. Any error in θ is essentially determined by the error in the input data, the elastic constants themselves. The boundary corresponding to the vanishing of the cubic shear elastic constant $(c_{11} - c_{12})/2$ is approximately delineated by the tables. The function $G(S,\tau)$ is equivalent to the cube root of de Launay's tabulated function $f(s,t)$, where $\tau = t + 2$; thus these tables are more convenient to use than his. Comparisons of the θ's at 0°K of eight different cubic crystals are made with those computed by other authors who used different methods of numerical integration. All results are found to agree within a few parts in a thousand. (auth)

7334 (N-66-27321) ELECTRON FLUX AND SPECTRUM IN THIN SILICON SAMPLES DURING GAMMA IRRADIATION: A COMPUTER STUDY. Walker, D. M.; Clement, J. D. (Georgia Inst. of Tech., Atlanta. School of Nuclear Engineering). Mar. 1966. 73p. (NASA-CR-75390; NE-4). CFSTI $3.00 cy, $0.65 mn.

The first half of a two-step computation involving the calculation of electron flux and spectrum in thin silicon samples during gamma irradiation is described. The second step involves using this information as input to a Monte Carlo calculation of displacement production. A justification of the cross-section equations used is given, the incorporation of these into an Algol computer program is described, and results of typical calculations are presented. Because the initial motivation of this work was its possible usefulness for analyzing spectrum effects in radiation damage studies for electronics devices, the applied relationship is noted throughout the paper. (STAR)

7335 (UCRL-17225) A CONVENIENT TABULATION OF THE DEBYE ENERGY, HEAT CAPACITY, FREE ENERGY AND ENTROPY FOR A CRYSTALLINE SOLID. Stark, Walter A.; Kortzeborn, R. N. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1966. Contract W-7405-eng-48. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Debye integrals for the heat capacity, energy, free energy and entropy were evaluated using a very fast and accurate numerical integration routine. The results are given as a function of T/θ_D, where T is absolute temperature and θ_D is the characteristic Debye temperature, in increments of 0.001 from 0.001 to 2.000 and in increments of 0.1 from 2.100 to 12.000. (auth)

7336 (UCRL-50118) PHOTOEMISSION INVESTIGATION OF THE BAND STRUCTURE OF FERROMAGNETIC Ni-Al ALLOYS. Breen, Walter Michael (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 15, 1966. Contract W-7405-eng-48. 76p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Univ. of California, Davis.

Photoemission measurements that probe the electronic band structure of ferromagnetic Ni-Al alloys have been made by using ultraviolet light from 4.5 to 11.4 eV to determine the excitation density of electronic quantum states down to about 6 eV below the Fermi level. Photoemission data were taken at room temperature on three Ni-Al alloys of compositions 89.6, 92.0, and 95.4 atomic percent Ni. The results are interpreted in terms of both the rigid band model and scattering phenomena. The optical density of states determined to within 25% is the same for all the Ni-Al alloys investigated. Only the position of the Fermi level changes as Al is added, in agreement with the rigid band model. Alloys of higher Al content were not investigated due to complications caused by a structural phase change. Results obtained from a pure Ni sample cleaned by argon bombardment and heat treatment are compared with those from a pure Ni sample formed by evaporation onto a substrate. The photoemission data from both samples are in complete agreement. Since the ferromagnetic intra-atomic exchange splitting in Ni is about 0.6 eV, a search for magnetic effects was made by taking data above the Curie temperature of the 89.6% Ni alloy. A predicted change due to magnetism is discussed in terms of the rigid band model; however, comparison of photoemission data above the Curie point with data below it shows no change due to magnetic effects. (auth)

7337 INFLUENCE OF RADIATION ON THE FORMATION AND UNIFORMITY OF CRYSTALS. Spitsyn, V. I.; Zimakov, I. E.; Dobroselskaya, N. P. Rost Kristallov, Akad. Nauk SSSR, Inst. Kristallogr., 5: 212-18(1965). (In Russian).

Data collected during the study of radioactive crystalline powders of barium tungstate, elementary sulfur, molybdenum tri- and disulfide, all synthesized by crystallization from solutions and gaseous vapors and precipitation from alloys, are presented. Nonradioactive and radioactive samples with differing specific activity were prepared under strictly identical conditions. The samples were studied by measuring their size and their specific surface, and by taking electron-microscope pictures. The preparation and analysis of the samples are described in detail. The results are given in the form of graphs showing the specific surface of crystals as a function of activity and a table summarizing the results of the particle-size analysis. Radiation was due to ^{185}W, ^{35}S, and ^{99}Mo isotopes. The paper concludes with a discussion of the microphotographs. (ATD)

7338 POINT DEFECT, OPTIC MODE, AND CRITICAL SCATTERING OF PHONONS AT LOW TEMPERATURES. Sievers, A. J.; Pohl, R. O. (Cornell Univ., Ithaca, N. Y.). pp I.B.1-9 of Proceedings of the 4th Conference on Thermal Conductivity. San Francisco, U. S. Naval Radiological Defense Lab., 1964.

Three mechanisms for phonon scattering are discussed. The low temperature thermal conductivity of KCl doped with I^- and also doped with Li is compared with some point defect scattering models. The low temperature thermal conductivity of strontium titanate is observed to vary with applied electric field. The field dependence is associated with the presence of a low frequency optic mode. Anomalous resistance peaks observed near phase transitions in UO_2 and KH_2PO_4 have been identified and interpreted as arising from critical phonon scattering. (auth)

7339 NEGATIVE ELECTROLYTIC BREAKDOWN IN PROTON-BOMBARDED LiF CRYSTAL. Kubo, Kazuko (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Jap., 21: 2599-2601(Dec. 1966).

The dielectric breakdown under proton bombardment of LiF was studied. A negative electrolytic breakdown figure was observed which was similar to that obtained by the conventional point-to-plate discharge. It is suggested that the breakdown is due to the potential difference between the range plane of the bombarding protons and the earthing point on the opposite surface. The breakdown figure consists of random and ⟨100⟩ paths with layers of precipitated Li metal. (auth)

7340 X-RAY LUMINESCENCE AND OPTICAL BURST IN THE PHOSPHOR KI(Tl). Parfianovich, I. A.; Krongauz, V. G. Opt. Spectros. (USSR) (Engl. Transl.), 20: 584-6(June 1966).

Translated from Opt. Spektros., 20: 1058-62(June 1966).

X-ray luminescence and optical burst were investigated in the KI(Tl) phosphor under various thermal and optical conditions and after x raying. Samples with different activator concentrations (7×10^{-5}, 5×10^{-4}, 3×10^{-3}, 2×10^{-2}, and 1 mole % of Tl in the melt) were studied. X-ray excitation was done at T = 105°K using a BSV-Mo tube (5 mA, 40 kV). The violet luminescence of the basic thallium centers was isolated by means of filters. The concentration dependences are illustrated with data on two of the samples, 1 mole % and 3×10^{-3} mole % of Tl. (M.H.R.)

7341 ETCHING OF PROTON-BOMBARDED NaF CRYSTAL. Kubo, Kazuko (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Jap., 21: 2411(Nov. 1966).

Specimens of NaF cleaved from a single crystal were bombarded in the [001] direction by 1.9-MeV protons up to 10^{17} protons/cm^2 at room temperature. The specimens were further cleaved and etched with propionic acid mixed with barium hydroxide. Irradiated portions of specimens were etched faster than unirradiated portions. A series of dense etch pips corresponding to edge dislocations was seen between irradiated and unirradiated portions. The number of isolated etch pips in the irradiated portion was smaller than in the unirradiated portion. The occurrence of glides in the NaF crystal during bombardment was verified. (A.G.W.)

7342 EXISTENCE OF STATIC PINNING OF DISLOCATIONS IN GAMMA-RAYED NaCl. Okada, Touichi; Shibata, Koji; Suita, Tokuo (Osaka Univ.). J. Phys. Soc. Jap., 21: 2412(Nov. 1966).

Gamma-irradiated NaCl crystals were examined by an indentation and etching (rosette pattern) technique. The specimens were heated to 350°C for 30 min and etched again. It was observed that the dislocations at the end of the wing of the rosette pattern were moved forward by the heat treatment. No movement was induced by the same treatment of an unirradiated specimen. These results indicate that the dislocation movement in irradiated crystals after heat treatment is connected with the annealing out of radioinduced defects that had contributed to the static pinning of dislocations. (A.G.W.)

7343 EFFECTS OF LATTICE VIBRATIONS ON DYNAMICAL DIFFRACTION OF ELECTRON AND X-RAYS. Ohtsuki, Y. H. (Tokyo Univ.). J. Phys. Soc. Jap., 21: 2300-6(Nov. 1966).

The temperature dependence of the generalized scattering factor corrected for inelastic excitations in the crystal is studied theoretically for dynamical diffraction of x rays and electrons. It is shown that the generalized scattering factors $\Phi_h = \varphi_h + C_{h0}$ for x-ray diffraction and $\chi_h = V_h + C_{h0}(Y)$ for electron diffraction (C_{h0} and $C_{h0}(Y)$ are parts due to inelastic electronic excitations, respectively) are modified by the usual Debye–Waller factor, when the thermal motion is described by the rigid-ion and Einstein models. (auth)

7344 PHOTOCHEMICALLY PRODUCED V BANDS IN KBr AND KCl. Ishii, Takehiko (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 21: 2202-7(Nov. 1966).

The properties of V bands produced by x irradiation at temperatures above 78°K have been investigated in KBr and KCl crystals. Preferential bleaching with polarized light revealed that many V bands have complicated composite structures in spite of the simplicity of their shapes. The observed dependence of shapes and positions of V bands on the duration of irradiation and the crystal temperature during irradiation are attributed to their composite nature. Some component bands were found to be destroyed by prolonged x irradiation. The band called V_4 in KCl was found not to correspond to the V_4 band in KBr. (auth)

7345 ON THE LUMINESCENCE OF γ-IRRADIATED KCl CRYSTALS INDUCED BY PLASTIC DEFORMATION. Kruglov, A. S.; El-Shanshoury, I. A.; Matta, M. K. (Atomic Energy Establishment, Cairo). J. Phys. Soc. Jap., 21: 2147-53(Nov. 1966).

The luminescence induced by plastic deformation of γ-irradiated KCl crystals is found to occur during loading from a stress lower than the elastic limit to the breakdown stress of the crystal. A similarity between the stress–strain curve and the load–luminescence curve is established. A luminescence yield stress of the irradiated crystals can be determined from the load–luminescence curves. Studies on slip band formation, pre-irradiation treatment of the crystals, and the effect of rate of load application are presented. Qualitative information about the nature of the luminescence produced during the deformation is given. A tentative model of the luminescence phenomenon from the start of the elastic deformation up to the stress under which the crystal is heavily deformed is presented. The model is based on the fact that the regions around dislocations contain a higher concentration of color centers than the average concentration in the bulk. The instability introduced to the regions of high concentration of color centers produces a considerable amount of luminescence. Spikes of luminescence produced at high stresses are due to the formation of slip bands. (auth)

7346 CONFIGURATION OF INTERSTITIAL ATOMS IN IRRADIATED GRAPHITE. Wallace, P. R. (McGill Univ., Montreal). Solid State Commun., 4: 521-4(Oct. 1966).

A mechanism is proposed by which the interstitial carbon atoms resulting from the irradiation of graphite form bonds with atoms in the adjacent graphite layers. The model forms a basis for understanding the expansion of graphite along the c axis under heavy irradiation, the formation of interstitial complexes, and the spontaneous release of stored energy in highly irradiated graphite when subjected to a mechanical stimulus. (auth)

7347 ELECTRON PARAMAGNETIC RESONANCE OF BARIUM-CONTAINING LiF QUENCHED AND THEN IRRADIATED WITH X RAYS. Bacquet, G.; Dugas, J.; Gautier, P. (Univ., Paris, Toulouse). Solid State Commun., 4: 553-6(Oct. 1966). (In French).

LiF containing Ba was studied by EPR. After heating and quenching, x-rayed samples exhibited spectra with a hyperfine structure characteristic of interaction of an unpaired electron with the six nearest neighbor fluorines. These spectra could be attributed to a V_1 center. Components of the hyperfine interaction tensor are given. (auth)

7348 TEMPERATURE DEPENDENCE OF F-CENTER PRODUCTION IN KCl. Comins, J. D.; Wedepohl, P. T. (Univ. of Witwatersrand, Johannesburg). Solid State Commun., 4: 537-40 (Oct. 1966).

The rate of production of F centers by x irradiation of KCl has been measured as a function of temperature. The rate increases sharply at about 175°K. Re-irradiation of bleached KCl samples shows that vacancies are destroyed during bleaching when the initial irradiation is performed at 77°K, but not when it is performed at 298°K. (auth)

7349 ENHANCEMENT OF THE SIGNAL-TO-BACKGROUND RATIO IN THE CRYSTAL STRUCTURE ANALYSIS OF HYDROGENOUS COMPOUNDS BY THE METHOD OF ELASTIC DIFFRACTION OF SLOW NEUTRONS. Caglioti, G.; Pompa, F. (CNEN, Ispra, Italy). Nuovo Cimento (10), 46B: 248-57(Dec. 11, 1966).

Possible applications of the method of elastic neutron diffraction to the important field of crystal structure analysis of hydrogenous compounds are presented and discussed. It is found that this method can be qualified as extremely suitable in the diffraction analysis of these compounds, since it leads to a strong enhancement of the (coherent) signal to (incoherent and otherwise overwhelming) background ratio in the diffraction pattern. Experimental tests are presented for the case of a nondeuterated powder sample of ammonium bromide. (auth)

7350 DIELECTRIC BREAKDOWN IN LiF CRYSTALS BOMBARDED BY ELECTRONS. Kubo, Kazuko (Japan Atomic Energy Research Inst., Tokyo). J. Appl. Phys., 37: 4722-8(Dec. 1966).

Dielectric breakdown phenomena were observed in LiF single crystals bombarded by electrons of 1 to 2 MeV. The Lichtenberg figures were developed in a layer which included the range plane of the bombarding electrons. The components of the figures lay in the directions ⟨221⟩, ⟨111⟩, ⟨114⟩, and a few ⟨100⟩, besides dominant ⟨110⟩, with small angle deviations. Turns and reflections of the path were found at the boundary of the layer. Structural alterations of the crystal, including edge dislocations, were observed around the large paths. These phenomena, which have not been observed in the previous experiments by the conventional method, are suggested to result from the intense ionization and heating due to electronic avalanches occurring in a rather long period of discharge time, superposing on the damage induced by electron bombardment. (auth)

7351 EFFECTS OF ELECTRON BOMBARDMENT ON SINGLE-CRYSTAL CdSe AT 77 DEG K. Kulp, B. A. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Appl. Phys., 37: 4936-8(Dec. 1966).

A threshold for electron radiation damage in CdSe is observed at 250 keV. A fluorescence emission band is produced with a peak intensity at 1.25 μ. Only a slight amount of annealing takes place up to 125°C. Above 150°C the fluorescence band at 1.25 μ increases in intensity due to heat treatment alone. The fluorescence can be removed by annealing at 500°C in excess selenium or cadmium. (auth)

7352 THE INDIRECT INTERACTION BETWEEN NUCLEAR OR IONIC SPINS AND THE RUDERMAN–KITTEL–KASUYA–YOSIDA APPROXIMATION. Vertogen, G.; Caspers, W. J. (Univ. of Groningen, Netherlands). Z. Phys., 198: 37-58(1967).

The matrix elements describing transitions between two excited states near to the groundstate of the free electron gas might considerably change the strength of the interaction between two nuclear or ionic spins as found in the R.K.K.Y. theory. To investigate this effect the third order correction to the groundstate energy was calculated. The calculation was performed with the assumption that the groundstate of the free-electron gas was nondegenerate and unpolarized. The hamiltonian describing the interaction between the electron system and the nuclear or ionic spin system was taken in the so-called R.K.K.Y. approximation, meaning that the interaction strength between the spins of the electrons and the spins of the nuclei or ions is taken independent of the momenta of the electrons before and after scattering. Our calculations showed that the third order correction tends to infinity. The density functions of electrons with spin up or down and the total density function up to second order also diverge. The only convergent result obtained is the polarization density up to second order. Therefore it is concluded that the usual R.K.K.Y. result is not correct. In order to get rid of these divergencies the upper limit ∞ in the integrals was replaced by a k_{cutoff}. It was possible to obtain an asymptotic form of the third order correction for large $k_{c.o.}$ (auth)

7353 GADOLINIUM HYPERFINE FIELDS. Gegenwarth, R. E. (Fordham Univ., Bronx, N. Y.); Budnick, J. I.; Skalski, S.; Wernick, J. H. Phys. Rev. Lett., 18: 9-10(Jan. 2, 1967).

The Gd hyperfine field, in the magnetically ordered state of several GdX_2 cubic Laves-phase compounds, shows a large variation in magnitude and sign. A comparison of the results with those of other rare earth systems supports the supposition of a constant 4f core–polarization field in the rare earths. (auth)

7354 THE KRAMER EFFECT IN RUBBER, ALUMINUM, AND COPPER. Durgaryan, A. H.; Karagezyan, A. G.; Movsesyan, K. O. (Erevan State Univ.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 264-6(1966). (In Russian).

The exoelectron emission from the rubber "Nairit," aluminum, and copper was measured. The Kramer-effect is observed in rubbers with crystalline phase. The influence of atmospheric oxygen and x rays on the amount of emission was investigated. (auth)

7355 TIME DEPENDENCE OF COAXIAL-DRIFT PROCESS. Rezanka, I. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Nucl. Instrum. Methods, 47: 181-2(Jan. 1967).

Time dependence of intrinsic region formation is derived in the approximation of great t for two limiting cases of coaxial drift processes. (auth)

7356 PHOTOCONDUCTIVITY SPECTRA OF OXYGEN-ALLOYED GERMANIUM CRYSTALS IRRADIATED WITH FAST ELECTRONS. Akimchenko, I. P.; Vavilov, V. S.; Plotnikov, A. P. (Lebedev Inst. of Physics, Moscow). Fiz. Tverd. Tela, 8: 1981-4(1966). (In Russian).

In addition to electrically active impurities, germanium crystals also contain neutral impurities, specifically oxygen, the concentration of which in normal crystals may reach 10^{16} cm^{-3}. It is not excluded that associations of point-contact defects with oxygen atoms may appear in Ge crystals upon irradiation. The Semiconductor Department of MGU (Kafedra poluprovodnikov MGU) grew an oxygen-alloyed germanium crystal. The crystal was subjected to dilation in an oxygen atmosphere with noncontrolled pressure. The single crystal obtained had n-type electroconductivity and a resistivity from 2 to 10 Ω-cm. It is concluded that the level E_c = 0.09 eV belongs to the association of the oxygen atom with a point-contact defect, the association appears only as a result of irradiation at room temperature, and it is analogous to the A center in silicon. Germanium of the n-type alloyed with oxygen to a concentration of 5×10^{17} cm^{-3} proved to be more radiation-stable than n-type material with the same resistivity but with a considerably lower oxygen concentration. Specimens of n-type Ge with an oxygen concentration of $\sim 5 \times 10^{17}$ cm^{-3} do not change their type of conductivity upon irradiation by a flux up to 6×10^{18} cm^{-2}, and the lifetime starts to decrease only after irradiation with a flux on the order of 10^{18} cm^{-2}. (ATD)

7357 THE INFLUENCE OF REACTOR NEUTRONS ON ELECTRIC CONDUCTIVITY AND HALL EFFECT OF GERMANIUM SINGLE CRYSTALS. Lautz, Guenter; Wolf, Dieter (Univ., Kiel). Atomkernenergie, 11: 457-66(1966).

To get further information on the structure and physical properties of radiation defects in semiconductors, the variations of the electric resistivity and the Hall coefficient of germanium single crystals under bombardment with reactor neutrons at 77°K are studied in detail. From these measurements the carrier mobility can also be obtained, based on the usual superposition of carrier interaction with acoustic phonons and ionic centers. The number of defects per incident neutron in n-type Ge is independent of the total neutron flux final to 7.6×10^{12} nvt and increases with carrier density; at 1.5×10^{15} electrons/cm^3 a radiation efficiency of 7.9 cm^{-1} is observed. However in p-type Ge this value is 4 times lower. The isochronal annealing of the specimens shows for both types of conductivity in 77°K < T < 145°K decreases of carrier concentration and mobility. In 145°K < T < 215°K in p-type Ge the number of carriers rises over the value before radiation, while the mobility reaches nearly the original value. In contradiction to this behavior there are further reductions in the carrier concentration and mobility for n-type Ge. Only for T > 215°K a real annealing with an approximation to the properties before radiation is stated. For the interpretation of these experimental results an atomistic model of the radiation defect is proposed, which holds true for both types of conductivity. (auth)

7358 ELECTRON IRRADIATION OF COPPER AND ALUMINUM ABOVE STAGE I. Neely, H. H. (Atomics International, Canoga Park, Calif.); Sosin, A. Phys. Rev., 152: 623-8(Dec. 9, 1966).

The dependence of the increase of electrical resistivity upon integrated electron flux φ was investigated in copper and aluminum. Irradiations were performed at 80°K using 1.1-MeV electrons. The resistivity was found to increase nonlinearly with φ up to the highest fluxes used: 10^{19} electrons/cm^2. At high φ values, the increase in resistivity appears to be proportional to $\varphi^{1/2}$. This dependence is predicted in a model in which interstitials, created during irradiation, are primarily annihilated by recombination with vacancies created concurrently during irradiation, but may alternatively be trapped by intrinsic defects such as impurities or dislocations. (auth)

7359 1.8-, 3.3-, AND 3.9-μ BANDS IN IRRADIATED SILICON: CORRELATIONS WITH THE DIVACANCY. Cheng, L. J. (Rensselaer Polytechnic Inst., Troy, N. Y.); Corelli, J. C.; Corbett, J. W.; Watkins, G. D. Phys. Rev., 152: 761-74(Dec. 9, 1966).

The annealing behavior and the uniaxial stress response of the radiation-induced defects causing the 1.8-, 3.3-, and 3.9-μ infrared absorption bands were studied after 45-MeV-electron and fast-neutron irradiation. The results indicate that these three bands all arise from the same defect. The defect exhibits two kinds of stress response, as evidenced by the dichroism induced in the bands: one due to electronic redistribution and the other due to atomic redistribution among the allowable orientations. It is determined that the defect has an atomic symmetry along a ⟨111⟩ direction and a transition dipole close to a perpendicular ⟨110⟩ direction. The activation energies for atomic reorientation and for annealing of the defect are the same, about 1.2 eV. Correlation of these results with the previous EPR studies indicates that the defect giving rise to these bands is the divacancy. Using the one-electron molecular-orbital model deduced for the divacancy from the EPR studies, some suggestions are given as to the nature of the optical transitions involved. (auth)

7360 PRESSURE-INDUCED PHONON FREQUENCY SHIFTS IN LEAD MEASURED BY INELASTIC NEUTRON SCATTERING. Lechner, R.; Quittner, G. (Reaktorzentrum, Seibersdorf, Austria). Phys. Rev. Lett., 17: 1259-61(Dec. 19, 1966).

The method of neutron spectrometry was used to measure the frequency shifts of six selected phonons in lead due to the application of a hydrostatic pressure of 3000 atm. The measurements were made with a conventional triple-axis spectrometer in a constant-Q mode of operation. The results are discussed. (M.O.W.)

7361 NEUTRON SCATTERING FROM PARAMAGNETIC $RbMnF_3$. Windsor, C. G. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 89: 825-31 (Dec. 1966).

The energy distribution of neutrons scattered from polycrystalline $RbMnF_3$ at room temperature (T/T_N = 2.8) was measured using time-of-flight analysis. Evidence is obtained for the existence of a cut-off in the energy distribution at large scattering vectors. The nearest-neighbor exchange interaction $2J_1(S_i \cdot S_j)$ is derived both by direct evaluation of the second moment of the energy distribution and from the best-fitting Gaussian. The results suggest $J_1/k = 3.3 \pm 0.3$°K, in good agreement with other determinations. A general calculation is made of the effect of biquadratic exchange on the second moment. It is shown that this is unlikely to affect the above result. (auth)

7362 RADIATION EFFECTS IN PILE-IRRADIATED LiF CRYSTALS. Shvarts, K. K.; Vitol, A. Ya.; Podin, A. V.; Kalnin, D. O.; Ekmanis, Yu. A. (Inst. of Physics, Riga). Phys. Status Solidi, 18: 897-909(Dec. 1, 1966).

A study is made of EPR, optical absorption (in the range 2 to 6 eV), and density variation of LiF crystals irradiated in a reactor with doses up to 10^{19} neutrons/cm^2. In the irradiated crystals the main paramagnetic defects are F centers. Some conclusions are drawn as to irradiation-induced expansion processes and the formation of color centers. Some details of the aggregation process of F centers are clarified by thermal annealing of the irradiated crystals. (auth)

7363 EXPERIMENTAL DETERMINATION OF THE MAXIMUM ESCAPE DEPTH OF MONOENERGETIC SECONDARY ELECTRONS. Mayer, H.; Hoelzl, J. (Technische Hochschule, Clausthal, Ger.). Phys. Status Solidi, 18: 779-85(Dec. 1, 1966). (In German).

The maximum escape depth of monoenergetic secondary electrons as a function of energy is obtained from the energy distribution of the secondary electrons. This is measured using a Pt target with a thin K film of a definite thickness bombarded with 200-eV primary electrons. The escape-depth curve determined in this way shows two pronounced minima at a few atomic layers. This result can be interpreted as being due to characteristic energy losses of electrons in potassium caused by the excitation of plasmons. The results are in good agreement with those obtained from photoelectric investigations. (auth)

7364 MULTIPLE ELECTRON DIFFRACTION. APPLICATION TO EVAPORATING UO_{2+x}. Ashbee, K. H. G. (Univ. of Bristol, Eng.). Phil. Mag., 14: 1031-6(Nov. 1966).

The orientations of a thin foil at points of multiple electron diffraction may be determined by inspection using a stereographic projection of Bragg contour pairs. This method has been used to evaluate the periodically repeated gross lattice bendings observed within the jagged edges of evaporating uranium dioxide foils. The "frilled" nature of these edges is interpreted in terms of surface layers with an O/U ratio different from that of the main crystal. (auth)

7365 EFFECT OF POINT DEFECTS ON ABSORPTION OF HIGH-ENERGY ELECTRONS PASSING THROUGH CRYSTALS. Hall, C. R.; Hirsch, P. B.; Booker, G. R. (Cambridge Univ., Eng.). Phil. Mag., 14: 979-89(Nov. 1966).

The effect of substitutional and interstitial atoms on the absorp-

tion of high-energy electrons is considered. Two mechanisms of absorption are discussed; viz., the contributions due to scattering by the additional scattering centers and due to displacements of the atoms surrounding the point defects. The absorption estimated on these two mechanisms is compared with the results of some experimental measurements on silicon doped with various impurities. (auth)

7366 ISOTHERMAL ANNEALING STUDIES ON VACANCY AND INTERSTITIAL LOOPS IN SINGLE-CRYSTAL GRAPHITE. **Turnbull, J. A.; Stagg, M. S. (Central Electricity Generating Board, Berkeley, Eng.). Phil. Mag., 14: 1049-66(Nov. 1966).**

Single crystals of graphite were treated in various ways to obtain either vacancy or interstitial loops ~10^3 Å diameter. The character of the loops was determined by diffraction contrast in the electron microscope. Thin foils from these crystals were isothermally annealed at temperatures between 2100 and 2600°C. The diameters of loops in a preselected area were measured after successive periods of annealing. It was found that in this temperature range, both vacancy and interstitial loops annealed out by dislocation climb. In some circumstances, large loops grew while the smaller ones shrank. An anisotropic diffusion model was used to show that both types of loop annealed with a common activation energy of 8.3 ± 0.3 eV. This has been identified as $E_f + \frac{1}{2}(E_{ma} + E_{mc})$, where E_f is the formation energy of the diffusing defect, E_{ma} and E_{mc} the migration energies parallel and perpendicular to the basal planes respectively. The analysis shows that this type of experiment cannot yield information as to the nature of the diffusing species. (auth)

7367 DISLOCATION LOOPS IN IRRADIATED ZIRCONIUM. **Gulden, T. D.; Bernstein, I. M. (Central Electricity Generating Board, Berkeley, Eng.). Phil. Mag., 14: 1087-91(Nov. 1966).**

Transmission electron microscope observations of damage in zirconium irradiated with krypton ions are reported. Dislocation loops were observed in irradiated and annealed specimens. These loops were interstitial in nature, fault-free, and oriented near primary and secondary prism planes. The Burgers vectors were of the type $b = (a/3)\langle 11\bar{2}0\rangle$. It is shown that the results reported are consistent with previous measurements of dimensional changes in irradiated zirconium. (auth)

7368 NUCLEAR HEXADECAPOLE INTERACTIONS. **Mahler, R. J. (National Bureau of Standards, Boulder, Colo.). Phys. Rev., 152: 325-30(Dec. 2, 1966).**

The nuclear hexadecapole matrix elements for the static and the one-phonon nuclear interactions are developed and are evaluated for $\Delta m = \pm 3$ and $\Delta m = \pm 4$ nuclear transitions involving a spin-$\frac{9}{2}$ nucleus in a crystal with $\bar{4}3m$ symmetry. An expression for the saturation factor for a general interaction that gives rise to nuclear-spin transitions involving the change in the z component of the spin by any amount $\Delta m = \pm n$ is developed and is used to derive the angular variation of the one-phonon, $\Delta m = \pm 3$ and $\Delta m = \pm 4$ nuclear hexadecapole interactions. Finally a way to end the speculation about the observation of the hexadecapole interaction is presented. (auth)

7369 THEORY AND OPERATION OF A PROTON-SPIN REFRIGERATOR. **Langley, K. H.; Jeffries, C. D. (Univ. of California, Berkeley). Phys. Rev., 152: 358-76(Dec. 2, 1966). (TID-23436).**

By rotating a crystal of $(Yb,Y)(C_2H_5SO_4)_3 \cdot 9H_2O$ (Yb:YES) at 60 rps in a magnetic field of 10 kOe at 1.4°K, nuclear polarizations as large as 19% are observed for the protons in the H_2O and C_2H_5 groups. This comes about because the Yb^{3+} ions have both an anisotropic g factor ($g_{||} = 3.35$, $g_{\perp} \approx 0$) and an anisotropic spin-lattice relaxation rate $\propto \cos^2\theta \sin^2\theta$, allowing the Yb^{3+} polarization at $\theta = 45°$ to be transferred to the protons by cross relaxation at $\theta = 90°$; cyclic repetition of this is a "spin refrigerator," which can, in principle, maintain a nuclear-spin polarization comparable to an electron-spin polarization. The paramagnetic and relaxation properties of Yb:YES are discussed in detail. Proton relaxation is studied and found to agree approximately with theoretical expectations. A general rate-equation theory of spin refrigerators is developed and used to interpret the measurements in Yb:YES. Although the present polarizations are limited by insufficient rotation speed and multiple spin flips, it is apparent that Yb:YES is a favorable substance, and that polarization of ~50% might be achieved at higher fields and higher speeds; application to polarized targets is suggested. (auth)

7370 INVESTIGATION OF THE EFFECT OF GAMMA RADIATION ON H_k AND H_c ON THIN PERMALLOY FILMS. **Lezhnenko, I. V. (Inst. of Metal Physics, Kiev). Ukr. Fiz. Zh., 11: 1153-4 (Oct. 1966). (In Ukrainian).**

An investigation was made of the effect of large doses of gamma rays on the coercive force H_c and anisotropy H_k. Glass or mica linings were coated with permalloy film in a vacuum of 3×10^{-5} mm Hg in a 100-Oe magnetic field applied in the plane of the film. Fe concentration was varied from 16 to 19% to make it possible to determine the influence of the magnetostriction constant on H_k during irradiation. The temperature of the lining was varied from 50 to 300°C. H_k was determined by means of low-frequency ferromagnetic resonance; a ferrotester was used to determine H_c. Error in the H_k and H_c measurements did not exceed 5%. Irradiation was carried out with gamma rays from a ^{60}Co source in different environments (air, argon, vacuum) by varying the intensity of the dose and the integral dose of radiation. No field was applied during irradiation. The temperature of the film did not exceed 30°C. From the tabulated results it can be seen that during the irradiation (in air) of films on glass linings with a gamma-ray flux of no more than 1650 R/sec, no change in H_k and H_c was detected within the limit of the experimental error; however the H_k of films on mica linings increased, while H_c remained constant. With an increase in the intensity of gamma-ray flux (irradiation in air) up to 2600 R/sec for a part of the films (approximately 75%) on glass linings, an increase in H_k and H_c was observed with saturation at doses of 2.5×10^8 R. This can be attributed to oxidation of the film since no such effect was observed when irradiation was done in vacuum or in an argon atmosphere. Irradiation in rarefied nitrogen produced no effect. It is concluded that gamma radiation from a ^{60}Co source will not affect the H_k and H_c of thin permalloy films if oxidation during irradiation can be prevented. (ATD)

7371 POINT DEFECT ELECTRON SCATTERING IN BERYLLIUM. **van Torne, L. I. (Martin Co., Orlando, Fla.). Phys. Status Solidi, 18: 737-42(Dec. 1, 1966).**

The dc resistivity due to electron scattering from a vacancy, an octahedral interstitial, and a tetrahedral interstitial in beryllium was computed by application of the diffraction model concept of pseudopotentials in the theory of metals. The resistivity values corresponding to 1 at. % concentration of each defect type are: octahedral interstitials, 0.283 μΩ cm; vacancies, 0.296 μΩ cm; and tetrahedral interstitials, 0.249 μΩ cm. (auth)

7372 RADIATION-INDUCED PHASE TRANSFORMATIONS IN PEROVSKITE-TYPE LATTICES AND THEIR THERMODYNAMIC TREATMENT. **Hauser, O.; Schenk, M. (Deutsche Akademie der Wissenschaften, Berlin. Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Phys. Status Solidi, 18: 547-55 (Dec. 1, 1966). (In German).**

A study is made of thermally and radiation-induced phase transformations between the room-temperature and high-temperature phases of $BaTiO_3$, $PbZrO_3$, and $PbTiO_3$. The shifts of the transformation temperatures are determined by x-ray and calorimetric examinations. The results are interpreted using structural and thermodynamic considerations. A thermodynamic treatment is presented, which explains both types of induced phase transformation. (auth)

7373 APPLICATION OF GREEN'S FUNCTION TECHNIQUE TO PARAMAGNETIC RESONANCE. **Frank, Barry. Vancouver, B. C., Univ. of British Columbia, 1965.**

Thesis.

A number of points that arose during a study of the paramagnetic resonance line shape problem is considered. The so-called moment method is discussed, and a new derivation of the moments of the line shape function is given. Single-spin operators are introduced, which simplify the calculation of these moments. The Green's function technique, as applied to this problem, and the decoupling approximations associated with the technique are looked at from the point of view of reliability and complexity. As a test of the reliability of any decoupling, a theorem concerning the moments of a line shape arising from such a decoupling is discussed and proved. The Green's function technique is applied to the case of the one-dimensional Ising model with spin ½, where no decoupling of the hierarchy of Green's function equations is necessary. A method of calculating thermal averages for this case, using difference equations, is given. (Dissertation Abstr.)

Theoretical Physics

Refer also to abstracts 6911, 6964–6966, 6969, 7474, 7552, and 7559.

7374 (AD-633674) MOMENTUM OPERATORS IN QUANTUM MECHANICS. **Arthurs, A. M. (Wisconsin Univ., Madison. Theoretical Chemistry Inst.). Apr. 28, 1966. Contract NsG-275-62. 12p. (WIS-TCI-164). CFSTI $3.00 cy, $0.65 mn.**

A representation for momentum operators corresponding to real observables is obtained by using functional integration in phase space. (auth)

7375 (AD-636507) RESEARCH PROGRAM IN RELATIVITY PHYSICS. Scientific Report. Bondi, H. (King's Coll., London (England)). Apr. 1966. Contract AF 61(052)-457. 478p. (ARL-66-0075). CFSTI $3.00 cy, $0.65 mn.

(1) Gravitational radiation. In this field a massive advance can be reported. A full understanding of the asymptotic character of space-time far from the source of the radiation was obtained. With this has come a complete understanding of the initial value problem, with conditions set on a forward light cone. Understanding of the nature of infinity in this field was materially advanced by using methods akin to those of projective geometry. (2) Epistomological foundations. Comparison of associated theories greatly clarified understanding of the distinguishing features of general relativity. (3) High gravitational potentials. The maximum red shift that can occur on the surface of a static sphere is now fully understood in relation to the physical conditions prescribed for the interior. (4) Slowly changing fields. A start was on the understanding of the significance of the conservation laws in slowly changing systems, and the way is beginning to be open for a full understanding of energy transfer in such cases. (5) Special solutions. A good deal of understanding was gained of a number of special solutions, e.g., some relating to those discovered by Harrison, to rotating bodies, to space-times associated with bounded empty regions, etc. (auth)

7376 (BNL-993) SUMMER INSTITUTE ON SPECTRAL THEORY AND STATISTICAL MECHANICS, 1965. Pincus, J. D. (ed.) (Brookhaven National Lab., Upton, N. Y.) Nov. 1966. Contract AT-30-2-GEN-16. 341p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Summer Institute on Spectral Theory and Statistical Mechanics was held during a five-week period beginning in June, 1965. Its purpose was to assemble a small group of mathematicians and physicists whose work contained some common elements of interest centering around recent results in spectral theory. Besides numerous informal talks, several lectures of an expository nature were given, and most of those are recorded in the notes contained in this volume. (auth)

7377 (JINR-P2-3009) ZADACHA DVUKH TESNTROV KVANTOVOI MEKHANIKI. (Two-Center Problem of Quantum Mechanics). Ponomarev, L. I.; Puzynina, T. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1966. 27p. (In Russian). Dep. mn.

The results of numerical calculations of the two-center problem of quantum mechanics are given. Some interesting properties of the systems Z_1eZ_2 are observed for the $Z_1 = 1$ and $Z_2 = 3, \ldots, 8$ values. In particular the existence of the σ-term intersections in such a system, which were previously predicted by theory, is proved. The existence of stable states of molecular ions for large distances between the nuclei Z_1 and Z_2 is proved. Such a peculiar phenomenon, pseudointersections of terms, having no dynamical nature is found out. Possible applications of the results obtained are discussed. (auth)

7378 (JINR-P2-3012) ZADACHA DRUKH TSENTROV KVANTOVOI MEKHANIKI. MATEMATICHESKAYA CHAST'. (Two-Center Problem of Quantum Mechanics. Mathematical Part). Ponomarev, L. I.; Puzynina, T. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 27p. (In Russian). Dep. mn.

An algorithm is given to calculate the eigenvalues and the wave functions of the two-center problem as well as the matrix elements by these functions. The method of solving the Sturm-Liouville problem for two coupled differential equations of the second order, which is developed here for this case, can be used for other problems. (auth)

7379 (JINR-P4-3011) KVANTOVOMEKHANICHESKAYA ZADACHA 3-x TEL, VZAIMODEISTVUYUSHCHIKH PO ZAKONU KULONA. (Quantum Mechanical Problem of Three Bodies Interacting According to the Coulomb Law). Ponomarev, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 13p. (In Russian). Dep. mn.

Some results of calculation of the matrix elements using the wave functions of two-body problem are given. These matrix elements permit the solution of many problems of quantum mechanics in another way. Possible applications of the obtained results to the description of the processes involving three bodies, which interact according to the Coulomb law, are discussed. As an example the binding energy of the $e^+e^-e^+$ system is calculated. (auth)

7380 (LA-3512) COMPUTATION OF CHARGE DISTRIBUTION ON OR NEAR EQUIPOTENTIAL SURFACES. Crandall, K. R. (Los Alamos Scientific Lab., N. Mex.). Apr. 1, 1966. Contract W-7405-eng-36. 48p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An interesting, and often practical, way of calculating the electrostatic potential and the electric field intensity in the neighborhood of a set of equipotential surfaces is to first find the charge density on each surface. Once the charge distribution is known, the problem of calculating the potential or field intensity at any point in the region is simply one of numerical integration. A straightforward method for computing the charge density is presented, employing three of the most useful tools of numerical analysis: the method of least squares, spline function approximations, and numerical integration using Gauss quadrature. The only restriction placed on the equipotential surfaces is that they be representable by a curve in a plane, such as a surface of revolution. (auth)

7381 (UCRL-14452) FAILURE OF THE MAYER IRREDUCIBLE CLUSTER THEOREM WITH WAVE MECHANICS. De Witt, Hugh; Fishbane, Paul (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 29, 1965. Contract W-7405-eng-48. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The wave mechanical form of the cluster integrals in the activity expansion for the pressure of nonideal gas is written in the Wiener functional integral form. The various pieces of the nth order cluster integral may then be easily expanded around the classical limit (Wigner-Kirkwood expansion) using the procedure of Gel'fand and Yaglom. It is shown that the reducible diagrams fail to factor at $0(\hbar^4)$, and thus the Mayer theorem that only irreducible diagrams come into the virial coefficients of the density expansion of the pressure is valid only through $0(\hbar^2)$. As an example, the WK expansion of the third virial coefficient is worked out to $0(\hbar^4)$. It is shown also how the functional integral formalism may be used to expand quantum statistical mechanical perturbation theory about the classical limit. (auth)

7382 EQUATIONS OF MOTION FOR TWO RELATIVISTIC MODELS OF SPIN PARTICLES IN WEAK EXTERNAL GRAVITATIONAL FIELD. Borelowski, Z. (Jagellonian Univ., Krakow). Acta Phys. Pol., 30: 777-90(Nov. 1966).

Spin particles represented by relativistic one and bipoint models in a weak external electric field are considered. The equations of motion of these particles contain a characteristic constant l having the dimension of a length which generates their spin as well as the diffluence. (These equations go into normal equations of geodesics, if we put $l = 0$.) The equations of motion of spin particles are linearized with respect to gravitational potentials and their partial derivatives. Then all terms containing the products of these potentials (or their derivatives) with l^2 are omitted (l, being a measure of the difference of the particle, is of the order of 10^{-11} to 10^{-13} cm). Assuming that the external gravitational field is so weak that the equations obtained in this approximation are already linear with respect to the particle coordinates, they are solved, based once on the metric of a plane wave and another time on the diagonal metric. It is shown that although (in the approximation) there is no perceptible influence of the field on the motion of the particle as a whole, however, if the particle is described in terms of the one-point model there occurs an increase of its acceleration energy, i.e., a specific energy generated by spin due to the presence of a gravitational field. In the case of the bipoint model there is no such behavior. (auth)

7383 SOME REMARKS ON WEINSTEIN'S METHOD OF THE SOLUTION OF THE WAVE EQUATION FOR AN OPTICAL ELECTRON. Bialas-Zabawa, A.; Skulska, E.; Walach, Z. (Jagellonian Univ., Krakow). Acta Phys. Pol., 30: 711-14(Nov. 1966).

The semi-empirical method of the determination of wave functions for an optical electron and of the potential of the field in which this electron exists given by Weinstein was generalized. In the original method of Weinstein the expression for the potential appearing in the wave equation for an optical electron is applied only in the case of atoms or ions having closed electron shells with the principal quantum number $n \leq 3$ and with a single electron in the external shell. An expression is given for the potential in the case of more complex atoms or ions with a single optical electron in the outer shell. (auth)

7384 A NEW FAMILY OF POLYNOMIALS WHICH GENERALIZES THE HERMITE-GRAD POLYNOMIALS IN THE SPACE-TIME OF SPECIAL RELATIVITY. Marle, Charles (Institut Francais du Petrole, Rueil-Malmaison, France). Compt. Rend., Ser. A. 263: 485-7(Oct. 3, 1966). (In French).

A new family of tensorial polynomials is described which is useful in obtaining an approximate solution to the relativistic Boltzmann equation through Grad's method. These polynomials are different from the ones already defined for the same purpose by Chernikov. (tr-auth)

7385 PHYSICAL FIELDS IN SPACE-TIME. Finzi, Bruno (Politecnico, Milan). Meccanica (Milan), 1: 7-14(Sept. 1966).

A general and effective procedure for obtaining equations that

govern a physical field is the variational, according to which the field equations express the conditions that must be verified if an expressive general element which relates to the whole range of variability is to remain stationary. Therefore, a comparative procedure is involved which is reducible in essence to that principle of virtual works which, since Lagrange, mechanics has passed on to science in general. A unitary form expounding such a procedure is developed, starting from the classical mechanical field of continuous systems, passing next to the corresponding relativistic field, and thence to the other relativistic fields of the macrocosm: electromagnetic and gravitational. From the same variational principle of Hamilton, formulated in space–time, which governs these relativistic fields of the macrocosm, are derived the relativistic equations which govern in the microcosm, according to wave mechanics, the neutral scalar fields of the π^0 mesons, the charged scalar fields of the π^+ and the π^- mesons, the neutral vector fields of the photons, the charged vector fields as well as the spinor fields of the electrons, protons, and neutrons. (BBB)

7386 IONIZATION LOSSES OF RELATIVISTIC PARTICLES MIGRATING FROM VACUUM TO THE MEDIUM. Lorikyan, M. P. (Erevan Inst. of Physics). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 259-61(1966). (In Russian).

The semi-quantitative method of deriving the Garibyan expression for the thickness of matter layer in which the density effect in ionization is absent is considered. (auth)

7387 RELATIVISTIC EQUATION OF MOTION FOR THE RADIATING ELECTRON, FREE OF RUNAWAY SOLUTIONS. Gromes, Dieter; Petzold, Joachim (Univ., Marburg, Ger.). Z. Phys., 198: 79-105(1967). (In German).

Analyzing the equations of motion of a spatially extended charge distribution leads to classical equations of motion for a radiating charged point particle. The particle is described by an intrinsic and an extrinsic momentum and not, as is normally done, by the mechanical momentum and the Lorentz force. A differential equation with retarded argument is obtained, which is free of runaway solutions and also contains the physical solutions of the older theories. Open questions are pointed out in detail. (auth)

7388 GRAVITATIONAL WARD IDENTITY AND PHOTON SCATTERING BY A GRAVITON. Gunzig, E. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 732-8(1966). (In French).

It is demonstrated that the scattering of a real photon by a graviton is not affected by the self-energy phenomena of the photon. This is due to the fact that the interaction of the gravitational field with virtual particles compensates exactly the renormalization of the photon wave function. (auth)

7389 INVARIANCE AND CONSERVATION LAWS IN CLASSICAL MECHANICS. II. Denman, Harry H. (Wayne State Univ., Detroit). J. Math. Phys. (N. Y.), 7: 1910-15(Nov. 1966).

The invariances of the equation of motion of a classical particle, to coordinate and time translations, to scale transformations and inversions, and to Galilean transformations, are considered individually. Resultant conditions on the equation of motion are given, and, for invariance to the one-parameter continuous transformations, it is shown that the equation of motion can be reduced from second to first order. Associated with each such reduction is a conservation law. The implications of the invariance of the system Lagrangian to these transformations are indicated, and the conservation laws, if any, associated with them. Some requirements on the Lagrangian for invariant equations of motion are also presented, and it is shown that the invariance of an equation of motion derived from a Lagrangian does not imply the invariance of that Lagrangian to the transformation. It is also shown that time-translation invariance of the equation of motion does not always require conservation of the Hamiltonian. (auth)

7390 CHARACTERIZING COHERENT STATES OF THE RADIATION FIELD. Jordan, Thomas F. (Univ. of Pittsburgh). J. Math. Phys. (N. Y.), 7: 2006-8(Nov. 1966).

Simple proofs are given for two properties of a Bose field discovered recently in the quantum-theoretic description of optical coherence. The first is the theorem of Glauber and Titulaer that first-order coherence means that only one mode is excited. The second is the theorem of Aharanov, Falkoff, Lerner, and Pendleton that eigenstates of the annihilation operators are characterized by their ability to factor when the system is divided into two channels. The restriction of the latter to the case of a single excited mode is removed. (auth)

7391 THE ASYMPTOTIC THEORY OF CHERENKOV RADIATION. Handelsman, R.; Lewis, R. M. (New York Univ.). J. Math. Phys. (N. Y.), 7: 1982-99(Nov. 1966).

Recently developed methods of asymptotic analysis are applied to the problem of Cherenkov radiation. The mathematical description of this physical phenomenon is given by the integro-differential system of equations for the electromagnetic field in a dispersive medium. The parameter λ is introduced into these equations, where λ is a characteristic frequency of the medium. It is for large λ that the asymptotic expansion of the electromagnetic field is sought. Isotropic, uniaxial crystalline and gyrotropic media are treated in detail. The source function which appears in the field equations is taken to be quite general, e.g., it may be used to represent the current associated with any moving "multipole" source. By applying the method of stationary phase to an integral representation of the solution, the leading term of the asymptotic expansion of the electromagnetic field is obtained. More precisely, a parametric representation of the expansion is found in which certain space–time curves called "rays" play a key role. An expression for the total energy of the radiation is then determined. (auth)

7392 RELATIVISTIC SPINOR FORMULATION OF STOKES PARAMETERS WITH APPLICATION TO THE INVERSE COMPTON EFFECT. De Young, David S. (Cornell Univ., Ithaca, N. Y.). J. Math. Phys. (N. Y.), 7: 1916-23(Nov. 1966).

A formulation of the Stokes parameters for light is found in terms of second-rank antisymmetric spinors, and arbitrary Lorentz transformations are made by using the unimodular representation of the Lorentz group. A three-component spinor form is established along with its accompanying representation of the Lorentz group, and the connection with the photon spin is explicitly shown. Differential Compton cross sections for any Lorentz frame are calculated. These are seen to be invariant only for particular polarization reference directions. (auth)

7393 RAINICH PROBLEM FOR COMPLEX SCALAR-ELECTROMAGNETIC FIELD. De, Nitaichand (Jadavpur Univ., Calcutta). Acta Phys. Pol., 30: 901-3(Nov. 1966).

Under which conditions a symmetric tensor may be considered as an energy-momentum tensor of a combined electromagnetic and complex scalar field were ascertained. (auth)

7394 RENORMALIZATION AND STATISTICAL MECHANICS IN MANY-PARTICLE SYSTEMS. I. HAMILTONIAN PERTURBATION METHOD. Wallace, Duane C. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 152: 247-60(Dec. 2, 1966).

A general system composed of many weakly interacting bosons and/or fermions is considered. The object is to develop a procedure for renormalizing the single-particle creation operators, so as to remove the interactions to successively higher orders of perturbation. The basic idea is that creation operators $\theta_i^\dagger$ must satisfy the Hamiltonian commutator equations $[\mathcal{H},\theta_i^\dagger] = \omega_i\theta_i^\dagger$, where $\mathcal{H}$ is the Hamiltonian and ω_i are the particle energies. For the many weakly interacting-particle system, the zeroth-order boson and fermion creation operators satisfy these equations to zeroth order. It is shown that if the creation operators are renormalized so as to satisfy the Hamiltonian commutator equations to order m, and also to satisfy the appropriate boson commutators and fermion anticommutators to order m, then the problem is solved to order m. In particular, the vectors formed by operating on the ground state with the renormalized creation operators, according to the usual boson and fermion occupation-number representation, are eigenvectors of $\mathcal{H}$ and are orthonormal, all to order m. A procedure is obtained for finding the (m + 1)-order contributions to the particle creation energies, in terms of the m-order operators. Explicit first-order calculations of these general results are provided for a system of bosons and a system of fermions, and these first-order results are shown to include similar results of Rayleigh–Schrödinger perturbation theory, the random-phase approximation, and the method of thermodynamic Green's functions. The problem of anharmonic lattice dynamics is studied in detail, and a method of undetermined coefficients is used to renormalize the phonon creation operators to first order. The phonon energies are calculated to second order, and this calculation shows that the interactions between renormalized phonons cannot be removed in second order. Statistical averages of the phonon energies give the energy shifts and lifetimes calculated previously by various propagator techniques. In addition, the renormalized energies are used to calculate the temperature-dependent part of the Helmholtz free energy correct to second order. As a final example, electron–phonon interactions in a normal metal are studied. The electron and phonon creation operators are renormalized to first order, the particle energies are calculated to second order, and statistical averages of the particle energies recover the usual thermodynamic Green's-function results for energy shifts and lifetimes. These examples show the simplicity by which the renormalization procedure obtains a great amount of detailed information about the single-particle nature of a many-particle system. (auth)

7395 RENORMALIZATION AND STATISTICAL MECHANICS IN MANY-PARTICLE SYSTEMS. II. STATISTICAL PERTURBA-

TION METHOD. Wallace, Duane C. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 152: 261-9(Dec. 2, 1966).

A general nonperturbation problem, described by the Hamiltonian $\mathcal{H}$, is considered. Approximate creation operators $\theta_i^\dagger$ are defined as operators that satisfy the Hamiltonian commutator equations $[\mathcal{H},\theta_i^\dagger] = \omega_i\theta_i^\dagger + R_i^\dagger$, where ω_i are the creation energies, and the remainder operators $R_i^\dagger$ are small in the sense that statistical averages involving the $R_i^\dagger$ are small. A zeroth approximation is to neglect the $R_i^\dagger$. In this case, a straight-forward derivation provides general relations between statistical averages such as $\langle\theta_i^\dagger\Omega\rangle$ and $\langle\theta_i^\dagger\Omega \mp \Omega\theta_i^\dagger\rangle$, where Ω is any operator. The usual boson and fermion occupation numbers are a trivial result of these zeroth-order relations. Corrections to the general zeroth-order relations arise from the $R_i^\dagger$; such corrections are considered in the spirit of perturbation theory. An explicit first-order correction is obtained for the averages $\langle\theta_i^\dagger\theta_i\rangle$, and this correction is related to a self-consistent energy-renormalization procedure. The present method is similar to the method of thermodynamic Green's functions in that the derivations given here do not require evaluation of any state vectors or of the partition function. The general results are applied to the Heisenberg ferromagnet problem. At low temperatures, the zeroth-order relations give the Bloch spin-wave results, and an approximate evaluation of the first-order contribution gives the leading term in Dyson's T^4 correction to the spontaneous magnetization. For arbitrary temperatures, the zeroth-order relations give the Tyablikov equations for $\langle S^z\rangle$, and Callen's results are obtained from the first-order corrections. These examples illustrate the simplicity of calculating statistical averages of functions of the $\theta_i^\dagger$, θ_i operators by the present method. (auth)

7396 EINSTEIN'S GRAVITATION-VACUUM FIELD FOR AN EXPANDING, ROTATION- AND SHEAR-FREE MOTION OF CLOSED PROBE PARTICLE. Mueller zum Hagen, Henning Commun. Math. Phys., 3: 292-312(1966). (In German).

The empty space field equations in Einstein's theory of gravitation are solved to determine all spaces admitting a timelike congruence without shear and rotation. The solutions belong to the class of degenerate static fields and their nonstatic extensions. (auth)

7397 POSSIBILITY OF VERIFYING GENERAL RELATIVITY USING ARTIFICIAL EARTH SATELLITES. Richard, Jean-Paul. Cah. Phys., 20: 85-156(Mar.-Apr. 1966). (In French).

Three types of experiments capable of demonstrating the effects of general relativity are discussed. The first deals with the orbital movement of an earth satellite. The second consists of measuring the rotation of the satellite about its own axis. The third consists in measuring the frequency lag of various clocks one of which is in the satellite. The problems would be set up theoretically by calculating the parameters in classical theory, adding the relativistic effects in perturbation theory, and then checking the results against the observed values. (G.O.Y.)

7398 PERSPECTIVES IN GEOMETRY AND RELATIVITY. Essays in Honor of Vaclav Hlavaty. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966. 500p. $15.00.

A series of research and expository papers is presented on a wide range of topics in geometry, relativity, and the considerable region of their overlap. The papers are published in honor of Vaclav Hlavaty. Among the subjects covered are groups, invariance, curvature, fibre spaces, cosmology, gravitational collapse, field theory, electromagnetic radiation, optics, energy, spinors in relativity, and the classification of gravitational fields. Separate abstracts were prepared for the 47 papers presented. (W.D.M.)

For abstracts of individual papers see: 6964–6966 and 7399–7442.

7399 DIFFERENTIAL GEOMETRY AND PHYSICAL THEORIES. Lichnerowicz, Andre (College de France, Paris). pp 1-6 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

A short historical paper on the interaction between physics and geometry is presented. (W.D.M.)

7400 WHAT IS EINSTEIN'S THEORY OF GRAVITATION? Synge, J. L. (Dublin Inst. for Advanced Studies). pp 7-15 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

A four-dimensional manifold is taken in which x^a are coordinates. On this background of four independent variables, a field theory is set up involving as field variables two symmetric tensors, g_{ab} and T_{ab}. The field equations read $G_{ab} = kT_{ab}$, where G_{ab} is the Einstein tensor, calculated from g_{ab} by a well-known procedure, and k is a universal constant. (W.D.M.)

7401 MAXIMAL COVARIANCE CONDITIONS AND KRETSCHMANN'S RELATIVITY GROUP. Anderson, James L. (Stevens Inst. of Tech., Hoboken, N. J.). pp 16-27 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

The general problem of how large a set of covariance conditions one can impose on a theory with a covariance group is discussed. In imposing such conditions, one makes the natural requirement that such conditions must be satisfiable by at least one member of every equivalence class of physically distinct solutions. Even so, we have shown in the cases of electrodynamics and relativity theory, that one can impose a number of conditions sufficient to reduce the covariance group down to the identity. As a consequence, we conclude that the Kretschmann definition of the relativity group of a theory is not a useful definition, since it always leads to the relativity group being the identity group. (auth)

7402 MULTIPOLE FIELDS IN LINEARIZED GENERAL RELATIVITY. Bonnor, W. B. (Queen Elizabeth Coll., London). pp 28-37 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

Multipole radiation fields in linearized general relativity are considered. Complete expressions for the quadrupole and octupole fields are obtained in terms of the corresponding traceless multipole moments. The field is then specialized to axial symmetry, and the solution is transformed into the form of metric given by Bondi. (auth)

7403 GEONS AND GRAVITATIONAL COLLAPSE. Brill, Dieter (Yale Univ., New Haven). pp 38-43 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

A simple procedure is given which allows treatment of the geon problem for general zero rest mass fields without numerical integration. This procedure is also applied to a discussion of the stability of geons toward gravitational collapse. (auth)

7404 TRANSLATIONAL INERTIAL SPIN EFFECT. Costa de Beauregard, O. (Institut Henri Poincare, Paris). pp 44-57 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

Explicit solutions of the equations of the Dirac–Weyl spin-½ massless particles and the Maxwell spin-1 massless particles are constructed which are z-independent and time-dependent through a pure harmonic factor exp (iWt); it is shown in both cases that, although the k_z component of the particle's momentum is identically zero, the j_z component of the Dirac current or the S_z component of the Poynting current is non-zero, the value being proportional to curl σ. Experiments using curved light beams should be able to test this "translational inertial spin effect." The theoretical fact underlying this new phenomenon is shown to be the asymmetry of the energy-momentum tensor T^{ij} of spinning media, which is related to the spin density σ^{ijk} by Tetrode's formula $T^{ij} - T^{ji} + \partial_k\sigma^{ijk} = 0$, in a way akin to the one through which the classical elasticity tensor $E^{\alpha\beta}$ is related to the torque density $\mu^{\alpha\beta}$ according to $E^{\alpha\beta} - E^{\beta\alpha} + \mu^{\alpha\beta} = 0$ (i, j, k, l = 1, 2, 3, 4; α, β, γ = 1, 2, 3). We thus have, in the Minkowskian approximation, a very definite theory, strongly suggesting that the natural application of geometric formalisms using an asymmetric connection is the theory of a generalized gravitational field including spin effects, rather than a synthetic theory of electromagnetism and gravitation. (auth)

7405 REFLECTED LIGHT SIGNALS. Coxeter, H. S. M. (Univ. of Toronto). pp 58-70 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

In a generalized Michelson–Morley experiment, two unaccelerated observers emit light signals alternately, each emitting a signal at the instant when he receives one from the other, and the first observer records the sequence of proper times for these events. If both observers measure time from the events when their space-like separation ϕ is perpendicular to both world lines (which are, in general, skew lines), if their relative rapidity at this origin of time is ψ, and if the world is Minkowskian, the proper time for the first observer's jth event is found to be $t_{2j} = t_1U_{2j-1}(\cosh\psi) - t_0U_{2j-2}(\cosh\psi)$, where $t_1 = t_0\cosh\psi + (t_0\sinh^2\psi + \phi^2)^{\frac{1}{2}}$ and $U_m(x)$ is a Chebyshev polynomial of the second kind. The analogous formulas in de Sitter's world are: $\tanh(t_{2j} + t_{2j-2})/2 = k\tanh t_{2j-1}$, $k = (\cosh\psi/\cos\phi)$, and $\cosh t_1\cosh t_0\cos\phi - \sinh t_1\sinh t_0\cosh\psi = 1$. (auth)

7406 ON CERTAIN EXSPACES AND THEIR RELATION TO RIEMANNIAN GEOMETRY. Craig, Homer V. (Univ. of Texas, Austin). pp 71-9 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

Some of the similarities and some of the points of difference between Riemannian spaces and certain exspaces are outlined. The typical exspace under consideration consists of the collection of curves in an enveloping Euclidean space (Cartesian coordinate system y) which are determined by $y^i = y^i(x, \ldots, x^N; dx^1/dt, \ldots, dx^N/$

$dt; \ldots; d^M x^1/dt^M, \ldots, d^M x^N/dt^M)$, i : 1 to L, L > N, and the set of all arcs $x^a = x^a(t)$ of class C^M in an N-dimensional base space. (auth)

7407 SOME APPLICATIONS OF THE THEORY OF PARALLEL DISTRIBUTIONS. Davies, E. T. (Univ. of Southampton, Eng.). pp 80-95 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

A differentiable (C^∞) manifold V of dimension N and a splitting up of the tangent space at every point of V into two complementary subspaces B and C of dimension n and N−n, respectively are considered, so that B and C form differentiable distributions of class C^∞ each characterized by a (1,1) tensor which is also denoted by B and C respectively. In such circumstances, it is known that there exist globally a metric with respect to which B and C are orthogonal, and a connection with respect to which B and C are parallel. The particular case in which N = 2n, and in which the distribution C is integrable is considered. An example of such a particular case is the tangent bundle T(M) of a manifold M of dimension n, which is examined in the cases where M is a Finsler or a Riemannian manifold. (auth)

7408 VECTORIAL REPRESENTATION OF THE CURVATURE IN GENERAL RELATIVITY: CONFORMAL TRANSFORMATIONS. Debever, Robert (Univ., Brussels). pp 96-104 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966. (In French).

A brief account is given of a general method for writing the curvature tensor and Einstein equations. This method is based on a vectorial representation of bivectors, in particular of the curvature form and connection form. It is a new version of the E. Newmann and R. Penrose spinor coefficient method, and of a spinorial calculus of forms by K. Bichteler. This method is applied to conformal changes of the metric, and in particular to specify the conformal choice of parameter along isotropic geodesics and to give an elaborated proof of the F. Pirani and A. Schild formula on the propagation of the distortion and generalization of geodesic deviation. (auth)

7409 EXISTENCE AND UNIQUENESS OF INTRINSIC ENERGY IN GENERAL RELATIVITY. Edelen, Dominic G. B. (RAND Corp., Santa Monica, Calif. Purdue Univ., Lafayette, Ind.). pp 105-14 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

The Einstein field equations of general relativity are shown to lead to a unique determination of an intrinsic energy density in any region of space−time which is occupied by a material medium. The usual procedure of adding a condition to the Einstein theory in order to obtain an analogous intrinsic quantity is thus unnecessary and possibly inconsistent. (auth)

7410 GALACTIC MORPHOLOGY AND SCALE. Edelen, Dominic G. B. (RAND Corp., Santa Monica, Calif. Purdue Univ., Lafayette, Ind.). pp 115-26 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

The derivation of a theory of galactic morphology based upon the Einstein field equations is summarized. In the linearized approximation, contours of the general elliptical galaxies as well as the perturbed forms NGC3115, NGC128, and IC3973 are obtained as equilibrium contours. The possibility of discretization of the linear scales of galaxies is also obtained and is tentatively confirmed by observations. (auth)

7411 GENERALIZED ELECTROMAGNETIC NULL FIELDS AND GEOMETRICAL OPTICS. Ehlers, Jurgen (Univ., Hamburg). pp 127-33 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

By means of an auxiliary "optical" metric introduced by W. Gordon, the propagation of electromagnetic fields through a transparent, moving medium in a general space−time is discussed. The characteristics and the propagation of the characteristic discontinuities along the bicharacteristics are determined. The properties of a special class of pure radiation fields analogous to the well-known vacuum null fields are determined and compared with the geometrical optics approximation. (auth)

7412 QUATERNIONS, BIVECTORS, AND THE LORENTZ GROUP. Ehlers, Juergen; Rindler, Wolfgang; Robinson, Ivor (Southwest Center for Advanced Studies, Dallas). pp 134-49 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

The versatility of quaternions (which is introduced in an unusual way) for a unified and coordinate-free discussion of the algebraic and topological properties of the Lorentz group and the related groups $SO_4(C)$, $SO_3(C)$, $SO_3(R)$, and $SL_2(C)$ is exhibited. A simple though apparently overlooked representation of quaternions in terms of bivectors is given, and the geometry of both bivectors and Lorentz transformations is studied. Since, as is generally known, the "logarithm" of a Lorentz matrix is a bivector, this complex of ideas is discussed in a bivector formalism. (W.D.M.)

7413 SURFACES WITH LIE QUADRICS TANGENT AT FOUR POINTS. Godeaux, Lucien (Belgian Mathematical Research Center, Liege). pp 161-6 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966. (In French).

To a point x of a surface (x) a sequence of quadrics $\Phi, \Phi^1, \Phi^2, \ldots$ is attached, the first of which is the Lie quadric; two consecutive quadrics are tangent at four points, these points being characteristic for the two quadrics. The case in which the quadric Φ^1 is the Lie quadric of a surface $(\bar{x})$ is studied. (auth)

7414 ELECTROMAGNETIC RADIATION. Goldberg, Joshua N. (Syracuse Univ., N. Y.). pp 167-75 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

Stokes' theorem is applied to obtain the total energy−momentum radiated by a localized charge−current distribution. These quantities are shown to be free tensors with respect to Lorentz transformations, and therefore, to have an invariant meaning for inertial observers. To obtain these results, it is necessary to assume that the radiation occurs in a finite pulse. With this condition in mind, the meaning of the components of angular momentum radiated is discussed. (auth)

7415 CONTRIBUTION TO THE THEORY OF SEMIGROUPS OF IDEMPOTENTS. Jordan, Pascual (Univ., Hamburg). pp 184-91 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

Several points of the mathematical theory of semigroups of idempotents are discussed. Especially the class of those semigroups is determined which can be constructed as subsystems of direct products, in a manner analogous to the representation of distributive lattices as sublattices of direct products with direct factors isomorphic to the lattice with two elements. (auth)

7416 CONNECTIONS AND THEIR INVARIANTS IN HIGHER-ORDER SPACES. Kawaguchi, Akitsugu (Hokkaido Univ., Sapporo). pp 192-200 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

By a higher-order space we understand a manifold with the totality of subspace elements of higher order associated with its every point. In order to define the connection in a higher-order space, the idea of tangent space of higher order and a vector of higher order and expansion are introduced, from which scleronomic and rheonomic transformations are considered. In a generalized metric space defined by giving the idea of the area of a subspace a priori, metric-preserving transformations or the generalized motions are taken into consideration. These transformations enable us to define the generalized affine and metric connections. In the higher-order spaces with these connections, there are many kinds of invariant quantities besides the torsion and curvature quantities. Of these quantities, some are explained which vanish identically in the case of the usual linear connection. (auth)

7417 ALTERNATIVE FIELD EQUATIONS IN GENERAL RELATIVITY. Kilmister, C. W. (London Univ.). pp 201-11 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

A distinction is drawn between the basic notions of general relativity and the specific set of field equations used by Einstein. In order to provide a better understanding of Einstein's choice of equations, alternative field equations are considered. (auth)

7418 ANALYTIC CONTINUATION AND GLOBAL THEOREMS IN GENERAL RELATIVITY. Komar, Arthur (Yeshiva Univ., New York). pp 212-16 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

For space−times which admit a timelike, hypersurface−orthogonal Killing vector field, it is possible to introduce the process of analytic continuation in such a fashion that new spaces with positive−definite metrics are obtained having the same Riemann and Ricci curvatures. The result is then employed to give simple proofs of some global theorems, and to construct new solutions of the vacuum field equations from known solutions. (auth)

7419 TENSORIAL AND TOPOLOGICAL FOUNDATIONS OF ELECTRIC NETWORKS. Kron, Gabriel (General Electric Co., Schenectady, N. Y.). pp 217-29 of Perspectives in Geometry

and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

It has been shown in previous publications that conventional electric network in its most elementary manifestations may be viewed as a 1 network containing 1-dimensional branches only. With the branches, a contravariant current vector i^{α}, a covariant voltage vector e_{α}, and a twice-covariant impedance tensor $z_{\alpha\beta}$ are associated. The power p in the 1 network in a linear form $e_{\alpha}\, i^{\alpha}$. It is shown that, when the surrounding 3-dimensional electromagnetic field is also taken into consideration — but again only in its most elementary manifestations — then three additional physical p networks exist, that may be said to be "induced" by the visible 1 network. While the current vector i^{α} still resides upon the branches of the 1 network, the voltage vector $e_{\alpha\bullet}$ now resides upon the surfaces of a dual 2 network. Consequently, the components of the impedance tensor $z_{\alpha\bullet\beta}$ reside within the volume elements of a tensor-product 3 network, while the components of the power $e_{\alpha\bullet}\, i^{\alpha}$ reside at the points of an intersection 0 network. (auth)

7420 GEOMETRODYNAMICS OF NULL ELECTROMAGNETIC FIELDS. Mishra, R. S. (Univ. of Allahabad, India); Misra, R. M. pp 230-7 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

It is shown that null electromagnetic fields in general relativity can be validly regarded as limiting cases of non-null electromagnetic fields, independently of the manner of going to the limit. (auth)

7421 EQUIVALENCE THEORY OF GENERAL METRIC LINE-ELEMENT SPACES. Moor, Arthur (Jozsef Attila Univ., Szeged). pp 238-44 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966. (In German).

A general metric line-element space is defined by the metric ground tensor g_{ij} and by the parameters L^{i}_{jk} and M^{i}_{jk} of the parallel displacement of vectors in the space. The necessary sufficient conditions for the existence of a coordinate transformation, which transforms two line-element spaces into one another, is given. If such a transformation exists, then the two line-element spaces are equivalent. (auth)

7422 TWO ROTATING UNIVERSES WITH DUST AND ELECTROMAGNETIC FIELD. Ozsvath, Istvan (Southwest Center for Advanced Studies, Dallas). pp 245-58 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

Two homogeneous solutions of the Einstein field equations with incoherent matter and electromagnetic radiation are given. In these universes, filled with dust and electromagnetic radiation, the rotation of the matter is rigid. It is felt that the above solutions are the only homogeneous solutions of the Einstein field equations with rigid rotation. (auth)

7423 GENERAL-RELATIVISTIC ENERGY FLUX AND ELEMENTARY OPTICS. Penrose, Roger (London Univ.). pp 259-74 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

It is suggested that the resultant focusing power of space–time curvature along a null ray is a good measure of the total energy flux (matter plus gravitation) across the ray. The effect of Weyl curvature is compared with that of purely astigmatic lenses, and nonlocal behavior is exhibited which reflects the essential nonlocality of gravitational energy. A precise measure of the focusing power of a system is suggested, and this is compared with the asymptotic expressions for the energy carried away by zero-mass radiation. (auth)

7424 ENERGY-MOMENTUM TENSORS. Peres, Asher (Israel Inst. of Tech., Haifa). pp 275-7 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

It is shown that the canonical energy–momentum quasi tensor differs from the metric energy–momentum tensor density by a complete divergence. Therefore, both expressions give the same value for the total energy and momentum of a closed physical system. (auth)

7425 TYPE OF THE FIELD AND THE TYPE OF THE ENERGY-MOMENTUM TENSOR. Petrov, A. Z. (Univ. of Kazan, USSR). pp 278-90 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

A problem is examined that occurs naturally in the general theory of relativity and is not based on any hypothesis other than the supposition that Einstein's field equations $R_{\alpha\beta} - \frac{1}{2}R\, g_{\alpha\beta} = T_{\alpha\beta}$ are satisfied. (auth)

7426 CONFORMAL GEOMETRY AND THE INTERPRETATION OF THE WEYL TENSOR. Pirani, F. A. E. (London Univ.); Schild, A. pp 291-309 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

The geometry of null geodesics is developed in a conformal space of hyperbolic normal signature. A generalization of parallel displacement (of directions) is defined, for null geodesics, in terms of the Lie derivative. The Weyl (conformal curvature) tensor is constructed using only conformally invariant operations. The construction yields a geometrical interpretation of the Weyl tensor (and, in the four-dimensional case, a physical interpretation). (auth)

7427 LORENTZ EQUATIONS IN SPINORIAL FORM. Plebanski, Jerzy (Centro de Investigacion y de Estudios Avanzados del Instituto Politecnico Nacional, Mexico City). pp 310-17 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

A simple set of spinorial differential equations of the first order is proposed which implies the tensorial Lorentz equations, although it is not equivalent to it. These equations are the natural counterparts of the Maxwell equations in spinorial form. The structure of the proposed spinorial relations is algebraically simpler than the structure of corresponding tensorial relations. This last point is illustrated by simple examples where the Lorentzian trajectories are obtained by integration of spinorial relations. (auth)

7428 EQUATIONS OF MOTION OF A SYSTEM OF CHARGED PARTICLES IN A GRAVITATIONAL FIELD. Rohrlich, F.; Winicour, J. (Syracuse Univ., N. Y.). pp 318-24 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

The Lorentz invariant classical theory of point charges recently proposed is generalized to the case of a system of point charges in a Riemann space with nonvanishing curvature. Starting with a nonlocal Lagrangian, the equations of motion are derived. They have formally the same structure as those derived by DeWitt and Brehme; i.e., they are the Dirac equation of 1938 in a Riemann space with an added term (tail term). The tail term, however, differs from that of DeWitt and Brehme. This difference is attributed to the arbitrariness inherent in the renormalization procedure used by these authors. The present theory does not require renormalization. It contains no divergent integrals. (auth)

7429 FLAT SPACE AND VARIATIONAL PRINCIPLE. Rosen, Nathan (Israel Inst. of Tech., Haifa). pp 325-7 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

It is found that if one attempts to characterize flat space by means of a variational principle one is led to a fourth-rank tensor satisfying a certain field equation. (auth)

7430 HAMILTONIAN FORMALISM IN RELATIVISTIC THEORIES. Rund, H. (Univ. of South Africa, Pretoria). pp 328-39 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

In the theory of parameter-invariant single integral problems in the calculus of variations, a certain invariant Hamiltonian function plays a special role. In the transition to relativistic quantum theory this suggests an operator H* (to be called the Hamiltonian operator, although it is not to be regarded as a type of energy operator), the basic postulate being an invariant equation of motion whose formal structure is similar to that of the Heisenberg equation. The latter differs significantly, however, from the equation proposed here in that derivatives of observables with respect to an invariant parameter (instead of time) are determined, while H* enters the usual commutator expression instead of the customary energy operators. The invariance requirement automatically leads to commutation relations involving the infinitesimal operators of the 4-dimensional proper orthogonal group and the operators Γ^{j} (j = 1, . . . , 4) by means of which H* is constructed, and these relations give rise to a conservation law which can be interpreted as referring to total angular momentum. Further invariance considerations yield sufficient information for the determination of sets of commutation rules to be satisfied by the Γ^{j}: different sets being supposed to define distinct physical systems. For each of these, the equations of motion are reducible to the noninvariant form of the usual Heisenberg type, and it is found that, for special sets of commutation rules, the operators which emerge from these equations are precisely the energy operator of the Dirac theory of the relativistic electron, or that of the Kemmer theory. In fact, in all cases these energy operators appear as fourth components of certain invariant operators. This not only provides a justification for the use of the Heisenberg equation in relativistic theories, but also permits the transition to the corresponding wave equations of the

theories of Dirac, Kemmer, et al., which thus emerge as special cases of the theory proposed here. (auth)

7431 LEMMA ON VACUUM GRAVITATIONAL FIELDS THAT PERMIT A HYPERSURFACE-ORTHOGONAL KILLING VECTOR. Sachs, R. K. (Univ. of Texas, Austin). pp 340-2 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

The Einstein field equations for a vacuum metric which permits a hypersurface-orthogonal Killing vector are reduced to a set of three equations in three unknowns (and three independent variables), together with a pair of involutive constraint equations. (auth)

7432 EINSTEIN'S UNIFIED FIELD THEORY. Santalo, L. A. (Univ., Buenos Aires). pp 343-52 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

First, the most general tensor T_{ij} of rank 2 in a space with a nonsymmetric affine connection which satisfies the following conditions is obtained: (a) it depends on the connection and its partial derivatives of the first and second order; (b) as a function of the connection it is, at most, of second degree. With T_{ij} and a nonsymmetric tensor g_{ij} the classical scalar density $T_{ij}g^{ij}|g|^{\lambda}$ is formed and the field equations are deduced from the corresponding variational principle. The equations are complicated, but they may be expressed in a simple way by introducing two new connections. Second, the necessary assumptions on T_{ij} in order that the field equations take the most simple form compatible with the nature of the problem are investigated. This form turns out to be that of the weak system of Einstein's unified theory of 1950. In particular, the simplifications induced by the assumptions of λ invariance and pseudo-Hermitian symmetry are investigated. (auth)

7433 IMBEDDING PROBLEM OF SPHERICALLY SYMMETRIC SPACE TIMES. Takeno, Hyoitiro (Hiroshima Univ.). pp 353-9 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

The problem of imbedding a spherically symmetric space-time in a five-dimensional space of constant curvature is dealt with from the viewpoint that a space-time is a geometrical entity independent of the special choice of the coordinate system and that the theorems stating geometrical or physical properties of the space-times become significant only when they are stated in invariant forms. The results are expressed in terms of tensor equations by using the theory of spherically symmetric space-times. (auth)

7434 RIEMANN-CHRISTOFFEL TENSOR AND TETRAD AND SELF-DUAL FORMALISMS. Taub, A. H. (Univ. of California, Berkeley). pp 360-8 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

The tetrad and self-dual formalisms are used to express the components of the Riemann-Christoffel tensor of a space-time in terms of the ordinary derivatives of the components of a tetrad of vectors. It is observed that the Riemann-Christoffel tensor is equivalent to a quadratic form and an anticorrelation in a complex three-dimensional vector space with a scalar product. Explicit expressions for these quantities are given in terms of quantities derived from the tetrad of vectors. (auth)

7435 WEAK GRAVITATIONAL FIELDS IN AN EXPANDING UNIVERSE TO ANY ORDER OF APPROXIMATION. Tauber, G. E. (Western Reserve Univ., Cleveland). pp 369-82 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

A method of successive approximations is developed to obtain the gravitational field in an expanding universe, to any order of approximation. The background metric used is the one which is conformal to flat space. It is shown that, by proper choice of the coordinate conditions, the linear equations can be put in the form resembling the tensor wave equation in an expanding universe. It is shown how solutions can be obtained under simplifying assumptions. As an example, the solution for a disturbance introduced in a universe composed of "dust" is given explicitly. (auth)

7436 REMARK ON THE CUBIC PRIMAL OF S_5 WHICH IS FILLED BY THE CHORDS OF A VERONESE SURFACE. Terracini, Alessandro (Univ., Turin). pp 383-8 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

In the projective space of five dimensions S_5, the primal V_3^4 which is filled by the chords of a Veronese surface has a Hessian primal H_3^4 that consists of the same V_3^4 taken twice. This is proved both synthetically and analytically. The paper ends with the remark that, by a similar argument, one gets a new type of linear system of ∞^3 quadrics in S_5, with vanishing Jacobian, and that in this way one can obtain new types of solutions to certain problems that occur in differential projective geometry. (auth)

7437 COMPARISON OF NEWTONIAN AND RELATIVISTIC THEORIES OF SPACE TIME. Trautman, Andrzej (Warsaw Univ.). pp 413-25 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

A review and comparison of geometrical hypotheses underlying Newtonian and relativistic theories of space and time are given. The similarity between the Newtonian and the Einstein cosmologies is explained and the field equations for a class of Riemannian space-times with close Newtonian analogs are written explicitly. (auth)

7438 MATTER AND SPACE STRUCTURE: THE INTERPRETATION OF EINSTEIN'S VACUUM EQUATIONS. Treder, Hans-Jurgen (Deutsche Akademie der Wissenschaften, Berlin). pp 426-35 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966. (In German).

Einstein's idea of a pure field physics postulates the representation of matter by the geometrical structure of space-time. The idea of "matter without matter density" is considered in analogy with Rainich's idea of "charge without charge density," using the integral form of Maxwell's equations and non-Euclidean topology. In this interpretation of general relativity, the Einstein equations for empty space are satisfied at each point of space-time but, in general, the integrals that define matter do not vanish. (auth)

7439 EINSTEIN'S UNIFIED FIELD THEORY. Udeschini, Paolo (Univ., Pavia, Milan). pp 436-47 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

In Einstein's unified field theory, the gravitational field and the electromagnetic field are represented by a single fundamental field. By symmetrization and skew symmetrization of the basic unsymmetric tensor, four tensors are obtained, two symmetric $h_{\alpha\beta}$, $l^{\alpha\beta}$ and two skew-symmetric, $k_{\alpha\beta}$, $m^{\alpha\beta}$. Some consequences of the unified field equations are examined, allowing determination of the electromagnetic part of the unified field (the conjugate tensor of $m^{\alpha\beta}$) and the gravitational part (the $h_{\alpha\beta}$ or the $l^{\alpha\beta}$ tensor). The sets of results are then compared with each other and with those of the gravitational theory. In the first approximation, the use of $h_{\alpha\beta}$ or of $l_{\alpha\beta}$ makes no difference, yet the second approximation is enough to point out the difference of results. (auth)

7440 CERTAIN TRANSFORMATIONS OF VECTOR FIELDS. Vincensini, Paul (Faculte des Sciences, Marseille). pp 448-55 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966. (In French).

Given a field of vectors (m,X) in E_n, the transformations (m,X) → (m′,X) of this field that conserve the vectors associated with the different points m and leave invariant the circulations $\int_C$ Xdm relative to all closed contours C of E_n are considered. The unitary fields (vectors of unit length) are studied, and among these the rectilinear fields (involving rectilinear integral curves). The case n = 3 leads, in particular, to properties of the transformation of the rectilinear congruences of ordinary Euclidean space with conservation of certain of their metrical elements, to the first order, as well as certain results relative to the infinitesimal transformations of surfaces of this space. (auth)

7441 MODEL FOR GRAVITATIONAL INSTABILITY. Wheeler, John Archibald (Princeton Univ., N. J.). pp 456-67 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

A collection of A baryons is distributed at uniform density throughout a region of space bounded by a spherical surface. The total mass-energy of the system is the sum of the rest mass, the energy of compression, and the negative gravitational energy. This total mass-energy is evaluated as a function of the degree of compression of the system on the foundation of the standard general relativity theory of gravitation and the following idealized and simplified equation of state: $\rho_{GW}^2 = (\mu^2 n^2 + L^4 n^{\frac{4}{3}})^{\frac{1}{2}}$, where $\rho^*(cm^{-2}) = (G/c^3)\rho(g/cm^2)$ is the density of mass-energy, and $n(cm^{-3})$ is the number density of baryons, and μ and L are well-determined constants. When the number of baryons is greater than the critical number $A_{crit} = 0.9795 \times 10^{57}$ there is no barrier against gravitational collapse, in the following sense: (1) the mass-energy decreases steadily as the density increases; and (2) the mass-energy goes to zero at a finite density (density great enough to curve up section of space occupied by matter into complete closure). A model system which contains a smaller number of baryons manifests a potential barrier against gravitational collapse: (1) at great

dilution, the mass-energy decreases as the density goes up, attention being restricted for simplicity here, as throughout the paper to configurations of uniform density; (2) as the density is further increased, the mass-energy reaches a minimum; (3) then the energy ascends to a maximum ("barrier summit"); and (4) finally it descends to zero, once more at a finite density. The height of the barrier against gravitational collapse is evaluated for the simple model and is found to reach a maximum of about 1.3×10^{32}g of mass-energy for about 0.2×10^{57} baryons, going to zero both at A = 0 and at $A = A_{crit}$. (auth)

7442 FIBERED SPACES AND PROJECTABLE TENSOR FIELDS. Yano, Kentaro; Ishihara, Shigeru (Tokyo Inst. of Tech.). pp 468-81 of Perspectives in Geometry and Relativity. Hoffmann, Banesh (ed.). Bloomington, Ind., Indiana University Press, 1966.

Fibered spaces and projectable tensor fields are defined, followed by a discussion of projections and lifts of tensor fields in a fibered space. After preparing some formulas for brackets and exterior derivatives, the tensor field of (1,1)-type and Nijenhuis tensor of this tensor field are studied. (auth)

7443 SELECTED PAPERS ON THE TRANSFER OF RADIATION. Menzel, Donald H. (ed.). New York, Dover Publications, Inc., 1966. 274p. $3.00.

Theories of the transfer of radiation have been applied to numerous problems in astronomy, physics, and engineering. A number of early papers on the subject, most of them difficult to find, are still important for reference and special studies. Six of these early important papers are reprinted here: (1) Radiation Through a Foggy Atmosphere, by Arthur Schuster (1905); (2) On The Equilibrium Of The Sun's Atmosphere, by K. Schwarzschild (1906); (3) Diffusion And Absorption In The Sun's Atmosphere, by K. Schwarzschild (1914); (4) On The Radiative Equilibrium Of The Stars, by A. S. Eddington (1916); (5) Note On The Absorption Of Radiation Within A Star, by S. Rosseland (1924); (6) Thermodynamics Of The Stars, by E. A. Milne (1930). (W.D.M.)

7444 NONLINEAR EFFECTS IN THE SCATTERING OF GRAVITATIONAL RADIATION. Torrence, Robert James. Pittsburgh, Univ. of Pittsburgh, 1965. 79p.

Thesis.

An effort is made to understand the implications of the nonlinearity of general relativity for the scattering of gravitational radiation by an isolated target. Empty-space solutions of the linearized Einstein equations are known which correspond to outgoing or ingoing radiation or to isolated distributions of matter. In the linear approximation solutions of each type may be added together to form a new solution with basic characteristics of a scattering problem, in particular, an imploding quadrupole wave, a Schwarzschild mass, and an exploding quadrupole wave. Working with the multipole formalism a method is developed for finding the second-order correction to such a linear solution. Interpretive methods specifying how we are to read from the solution information about the asymptotic radiation field and the behavior of the target are devised. Three tentative conclusions about the particular problem are drawn. If a first-order quadrupole wave implodes from infinity and explodes back out again, there will be second-order quadrupole and 16-pole waves self-scattered in the direction of propagation which will, however, interfere destructively so that they will not be observable asymptotically. The overlapping of that part of the quadrupole wave still ingoing with that part already coming back out will produce no asymptotic radiation. The target must, under the influence of the passing quadrupole gravitational field, either grow a quadrupole moment or emit quadrupole radiation. The methods developed appear applicable to a scattering problem involving a much more complicated target (moving, spinning, nonspherical) and any combination of incident radiation fields (quadrupole, octupole, etc.). (Dissertation Abstr.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 7478.

Electromagnetic

7445 (DESY–66/27) ELASTIC ELECTRON-PROTON SCATTERING AT MOMENTUM TRANSFERS UP TO 110 FERMI^{-2}. Behrend, H. J.; Brasse, F. W.; Engler, J.; Hultschig, H.; Galster, S.; Hartwig, G.; Schopper, H.; Ganssauge, E. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct. 1966. 44p. Dep. mn.

Elastic electron–proton cross sections were measured at various angles between 32 and 130°, and with momentum transfers of q^2 = 39, 60, 80, and 110 f^{-2}. Two single quadrupole spectrometers, movable around a common liquid-hydrogen target, were used to analyze the momentum of the scattered electrons. Cherenkov and shower counters discriminated against pion and low-energy background. As a cross-section reference, recoil protons from elastic scattering at q^2 = 10 f^{-2} were used, with a quantameter serving as an intermediate monitor. The data are consistent with the Rosenbluth formula, giving real form factors G_E and G_M. Both continue to decrease with increasing momentum transfer, but somewhat faster than indicated by previous measurements. (auth)

7446 (JINR-E13-2971) NEW METHOD FOR MEASURING THE EFFECTIVE MASS IN THE DECAYS: $x \rightarrow \gamma + \gamma$. Azimov, M. A.; Belousov, A. S.; Chuvilo, I. V.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 16p. Dep. mn.

A new method is described for effective mass measurement in the decays: $x \rightarrow \gamma + \gamma$ etc. with a two-channel system of jointly operating spark chambers and Cherenkov gamma spectrometer. The system is calibrated for the decays: $\eta^0 \rightarrow \gamma + \gamma$. The $\Delta M/M$ resolution was obtained to be $\pm 10\%$. (auth)

7447 (JINR-P1-2990) LIVNI V SVINTSE, OBRAZOVANNYE γ-KVANTAMI S ENERGIEI OT 0,1 DO 1 GeV. (Showers in Lead Produced by 0,1 to 1 GeV γ-Quanta). Zaimidoroga, O. A.; Prokoshkin, Yu. D.; Tsupko-Sitnikov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 13p. (In Russian). Dep. mn.

The characteristics of the showers, produced in lead by γ-quanta with the energy 0.1; 0.2; 0.3; 0.5, and 1 GeV, are determined on the basis of the experimental data on distributions according to the electron number in showers, generated by electrons in lead. (auth)

7448 COEFFICIENT OF INELASTICITY ($\overline{K}\gamma$) DURING THE INTERACTION OF PARTICLES WITH CARBON NUCLEI. Azimov, S. A.; Polyak, Yu. V.; Abdullaev, R. S. Dokl. Akad. Nauk Uz. SSR, 22: No. 3, 12-13(1965). (In Russian).

The electron–photon component of the particles which originated as the result of the interaction of high-energy particles with a generator consisting of a graphite block was studied. The coefficient for the transfer of energy in this component was determined by using cascade curves. (J.F.P.)

7449 THE REACTION $\gamma p \rightarrow N^{*++}\pi^-$ AT ENERGIES UP TO 5.8 GeV. Hilpert, H. G. (Technische Hochschule, Aachen); Reimann, G.; Schuettler, E.; (and others). Phys. Lett., 23: 707-10 (Dec. 19, 1966).

Experimental results on the total and differential cross sections and on the decay angular distribution for the reaction $\gamma p \rightarrow N^{*++}\pi^-$ at energies between 0.3 GeV and 5.8 GeV are presented and compared with theoretical predictions. (auth)

7450 PHOTOPRODUCTION OF MESONS (π^+) ON PROTONS NEAR THE THRESHOLD. Adamovich, M. I.; Larionova, V. G.; Lebedev, A. I.; Kharlamov, S. P.; Yagudina, F. Ya. Tr. Fiz. Inst., Akad. Nauk SSSR, 34: 57-93(1966). (In Russian).

Experimental studies were made of the $\gamma + p \rightarrow n + \pi^+$ process. The results of some calculations of cross sections for the process are discussed. The data obtained are correlated with the predictions of dispersion relations. Certain parameters of low-energy pion physics were determined with a high degree of accuracy, and an upper limit for the constant of the γ-3π interaction was obtained. 71 references. (R.V.J.)

7451 PHOTOPRODUCTION OF MESONS (π^0) ON DEUTERIUM NEAR THE THRESHOLD. Lebedev, A. I.; Tamm, E. I. Tr. Fiz. Inst., Akad. Nauk SSSR, 34: 3-56(1966). (In Russian).

Theoretical and experimental studies were made of meson (π^0) photoproduction on deuterium near the threshold. The results were analyzed using phenomenological theory with the impulse approximation. The results of calculations for elastic ($\gamma + d \rightarrow d + \pi^0$) and inelastic ($\gamma + d \rightarrow p + n + \pi^0$) meson ($\pi^0$) photoproduction on deuterons are presented; and the application of these processes in studies of $\gamma\pi\rho$ and $\gamma\pi\omega$ interactions and $\gamma + n \rightarrow n + \pi^0$ processes is discussed. 57 references. (R.V.J.)

Weak

7452 (AD–637480) BETA SPECTRUM OF NEUTRON DECAY IN COINCIDENCE WITH RECOIL PROTONS. Annual Scientific Summary Report No. 1, February 1, 1965–January 31, 1966. Weinzierl, P. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). Contract AF 61(052)-857. 43p. (AFOSR–66-0833). CFSTI $3.00 cy, $0.65 mn.

It is shown that a precise measurement of the angular correlation coefficient yields theoretically important information about weak interactions. Different experimental approaches for the determination of this quantity were studied. The comparison between coincidence measurements and a determination and evaluation of the shape of the proton recoil spectrum led to the decision to choose the latter method. Detailed calculations were carried out on the precision to be expected from different types of proton spectrometers. A high vacuum tangential beam tube, accessible at both ends, is well suited as decay proton source for a precisely controlled spectrometry. It is planned to use a spherical condenser spectrometer and a specially developed low background detector for the postaccelerated protons. The beam hole at the opposite side of the reactor will be used for insertion of a test source for simulating decay protons to check the ion optical properties, transmission, etc. between and during the spectrum measurements. (auth)

7453 CIRCULAR POLARIZATION OF THE RADIATION EMITTED IN THE COLLISION OF A NEUTRINO WITH A NUCLEON. Sarkar, S. (Indian Association for the Cultivation of Science, Calcutta). Proc. Phys. Soc. (London), 89: 821-4(Dec. 1966).

A study was made of the circular polarization of the bremsstrahlung emitted in the collision of a high-energy neutrino with a nucleon. (auth)

7454 MEASUREMENT OF THE DECAY RATE OF $K_2^0 \rightarrow \pi^0 + \pi^0$. Cronin, James W.; Kunz, Paul F.; Risk, Winthrop S.; Wheeler, Paul C. (Princeton Univ., N. J.). Phys. Rev. Lett., 18: 25-9(Jan. 2, 1967).

A measurement of the decay rate for $K_2^0 \rightarrow \pi^0 + \pi^0$ is reported. The technique of measurement uses the fact that the energy spectrum of the gamma rays from $K_2^0 \rightarrow \pi^0 + \pi^0$ extends to significantly higher energies than the major background $K_2^0 \rightarrow 3\pi^0$ in the K_2^0 center-of-mass system. (B.G.D.)

7455 MEASUREMENT OF THE DECAY OF THE LONG-LIVED NEUTRAL K MESON INTO TWO NEUTRAL PIONS. Gaillard, J.-M. (CERN, Geneva); Krienen, F.; Galbraith, W.; (and others). Phys. Rev. Lett., 18: 20-5(Jan. 2, 1967).

A measurement of the decay rate for $K_L^0 \rightarrow \pi^0 + \pi^0$ is reported. The measured relative transition amplitude $|\eta^{00}|$ is $(4.3^{+1.1}_{-2.2}) \times 10^{-3}$. This value differs from that given by the superweak theory by 3.0 standard deviations. The result indicates that the CP nonconservation is partially due to a $\Delta I \geq 3/2$ amplitude. (B.G.D.)

Strong (Baryon-Induced)

7456 (JINR-P-2861) AMPLITUDY UPRUGOGO RASSEYANIYA NUKLONOV NUKLONAMI. (Elastic N-N-Scattering Amplitudes). Golovin, B. M.; Rozanova, A. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 46p. Dep. mn.

On the basis of the previously published data on the phase-shift analysis, the elastic N-N scattering amplitudes are calculated for energies in the range 23 to 630 Mev. Some peculiarities of the amplitudes are mentioned. The values obtained for spinless terms are compared with the predictions based on dispersion relations. (auth)

7457 OBSERVATION OF SPIN ALIGNMENT OF RESONANCES PRODUCED IN THE 3-BODY REACTIONS: $\bar{p}p \rightarrow \bar{p}p\omega^0$ AND $\bar{p}p \rightarrow \bar{\Delta}^{*--}\Delta^{*++}\pi^0$ AT 5.7 GeV/c. Alles-Borelli, V.;

French, B.; Frisk, A.; Michejda, L. (CERN, Geneva). Nuovo Cimento (10), 46A: 438-58(Dec. 1, 1966).

The reaction $\bar{p}p \rightarrow \bar{p}p\pi^-\pi^+\pi^0$ was studied at 5.7 GeV/c in the 81 cm Saclay hydrogen bubble chamber. Production of ω^0 and η^0 mesons was observed. The ω^0 mesons are collimated in the forward and backward directions in the cms. The decay angular distribution of the ω^0 indicates that it is produced with the spin aligned in the plane perpendicular to the incident $\bar{p}$ (or p) momentum transformed to the ω^0 rest frame, an effect which is enhanced when the four-momentum transfer t is limited to $|t| < 0.5$ $(GeV/c)^2$. It was found that of the observed Δ^{*2+} (1238) and $\bar{\Delta}^{*2-}$ (1238) isobars about 80% are produced in pairs in the 3-body reaction $\bar{p}p \rightarrow \bar{\Delta}^{*2-}\Delta^{*2+}\pi^0$. In this reaction the Δ^* isobars are produced in aligned states with the spin directions of the Δ^* and $\bar{\Delta}^*$ being strongly correlated such that there are few events in which both the Δ^* and $\bar{\Delta}^*$ decay with the p and $\bar{p}$ from the isobars making large angles relative to initial p or $\bar{p}$ direction transformed into the isobar rest frame. (auth)

7458 PARTICLE PRODUCTION BY 8 GeV/c PROTONS INCIDENT ON Al, Cu, Pb, AND W. Audus, M. F. (National Inst. for Research in Nuclear Science, Chilton, Eng.); Bendall, R. G.; Egginton, A. J.; O'Connell, M. J.; Rowe, R. C.; Sheehan, M. J.; Wilson, E. J. N.; Homer, R. J.; O'Dell, A. W. Nuovo Cimento (10), 46A: 502-13(Dec. 1, 1966).

Measurements of pion, proton, and kaon production from a lead target in the 8 GeV/c external proton beam of NIMROD were made for production angles of 0 and 5° as a function of secondary momentum. The measurements confirm that pion production cross-sections are increasing more rapidly with primary momentum at 8 GeV/c than above 12 GeV/c. There is evidence of an enhancement of zero degree π^+ production at 3 GeV/c secondary momentum which is not inconsistent with peripheral production of Δ^* (1238). Comparison of several target materials suggests that pion fluxes from copper are as much as 80% higher than from other dense materials. Empirical formulas which describe pion production at higher primary momenta are considered in relation to the data. (auth)

7459 A MEASUREMENT OF THE MAGNETIC MOMENT OF THE Λ HYPERON. Charriere, G. (Univ., Lausanne, Switzerland); Gailloud, M.; Rosselet, Ph.; (and others). Nuovo Cimento (10), 46A: 205-22(Nov. 21, 1966).

A pulsed magnetic field of 150 kG was applied in a transverse direction to the path of polarized Λ^0 hyperons created by bombarding a polyethylene target with 1.05 GeV/c negative pions. In the interval of distance between 10 and 12 cm from the target, the hyperons decaying in the mode $\Lambda^0 \rightarrow p + \pi^-$ were detected in Ilford nuclear-research emulsions. The observation of the anisotropy in the direction of the decay products in the rest frames of the hyperons was used to measure the rotation of the polarization vector in the magnetic field and hence to determine the magnetic moment (μ_Λ) of the Λ^0 hyperon. An analysis of 151 decays gave a value for $\mu_\Lambda = (-0.50 \pm 0.28)$ nucleon magnetons. (auth)

Strong (Meson-Induced)

7460 (CEA-R-3032) ETUDE DU SYSTEME $\overline{K}\pi$ DANS LES ETATS FINALS A 3 CORPS PRODUITS PAR LES INTERACTIONS K^-p A 3 GeV/C. (Study of the $\overline{K}\pi$ System in the 3 Bodies Final States, Produced by 3 GeV/c K^-p Interactions). Verglas, Alain (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 78p. (In French). Dep. mn.

Thesis submitted to Univ., Paris.

The $K^-P \rightarrow K^*$ (891) N reaction is a good example of a quasi-two-body phenomenon, exhibiting the characteristics of periperism. The predictions of the one meson exchange, and absorption models are compared with the experimental results. Conclusions are drawn concerning the production mechanism of the $KP \rightarrow K^*$ N reaction, as well as on the validity of the models. Finally, the K* (1400) resonance is studied and its isospin determined. (auth)

7461 (JINR-P1-2963) NEUPRUGIE π^--p VZAIMODEISTVIYA PRI ENERGII 7.5 GeV. CHAST III. 4-LUCHEVYE SOBYTIYA S NEITRONAMI. (Inelastic π^--p-Interactions at Energy 7.5 GeV. Four-Prong Events With Neutrons). Balya, E.; Balya, O.; Belyakov, V. A.; Kladnitskaya, E. N.; Kuznetsova, E. S.; Mikhul, A.; Sabeu, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 18p. (In Russian). Dep. mn.

524 events of the reaction $\pi^-p \rightarrow n\pi^+\pi^+\pi^-\pi^-m\pi^0$ ($m \geq 0$) at 7.5 GeV were analyzed. The cross section is found to be $\sigma = 3.7 \pm 0.3$ mb. The correlation is established between transverse and longitudinal particle momenta in the cms. Production of a ρ^0-meson and a $N^*_{3,3}$-isobar is observed. There is some indication to the production of A_1 and A_2 mesons too. (auth)

7462 (JINR-P1-2996) IZMERENIE OTNOSHENIYA VEROYATNOSTEI REAKTSII $\pi^-d \rightarrow nn$ I $\pi^-d \rightarrow nn\gamma$. (Measurement of the Probability Ratio for $\pi^-d \rightarrow nn$ and $\pi^-d \rightarrow nn\gamma$ Reactions). Musin, M. A.; Petrukhin, V. I.; Prokoshkin, Yu. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 14p. (In Russian). Dep. mn.

The probability ratio for the reactions $S = W(\pi^-d \rightarrow nn)/W(\pi^-d \rightarrow nn\gamma)$, induced by the stopping of negative mesons in deuterium, is determined by comparing the γ quanta yields from hydrogen and deuterium gas target. The value obtained ($S = 2.94 \pm 0.15$) is in disagreement with that calculated by data on π-meson production in collisions of nucleons and γ quanta with nucleons (1.6 ± 0.4). (auth)

7463 (JINR-P1-2997) IZUCHENIE REAKTSII $\pi^+ + p \rightarrow \pi^+p\pi^0$ PRI IMPUL'SE π^+ MEZONOV 2.34 GeV/c. (Investigation of the Reaction $\pi^+ + p \rightarrow \pi^+p\pi^0$-Meson Momentum of 2.34 GeV/c). Angelov, N. S.; Gramenitskii, I. M.; Zlateva, A. I. (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 24p. (In Russian). Dep. mn.

Characteristics of the reaction $\pi^+ + p \rightarrow \pi^+p\pi^0$ at the primary π^+-meson momentum of 2.34 GeV/c were investigated on the photographs of a 40 cm hydrogen bubble chamber. Production of ρ^+-mesons and $N^*_{3,3}$ isobars was studied. The differential cross section $d\sigma_\rho/dt$ and the matrix for ρ^+-mesons and isobar were obtained. The experimental data are compared with the results of calculation according to the absorption model. (auth)

7464 (JINR-P1-3008) STRUKTURA V UPRUGOM π^+p-RASSEYANII NAZAD. (Structure in Elastic Backward π^+p-Scattering). Vovenko, A. S.; Gus'kov, B. N.; Dobrovol'skii, T.; Likhachev, M. F.; Lyubimov, A. L.; Matulenko, Yu. A.; Stavinskii, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 9p. (In Russian). Dep. mn.

The energy dependence of the differential cross section of elastic π^+p-scattering at about 174° in the cms is measured in the range of 2.06 to 4.70 GeV/c. Maxima of this cross section occur at the energies of formation of baryon resonance Δ (2420) and Δ (2840). This structure is used to determine the parity of these isobars. (auth)

7465 (NYO-3178-3) RESEARCH IN ELEMENTARY PARTICLE PHYSICS. Technical Progress Report, September 1, 1965–June 15, 1966. Wolf, Sanford E. (Brandeis Univ., Waltham, Mass. Dept. of Physics). Contract AT(30-1)-3178. 13p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Several experiments on K^-–nucleon interactions in the range of 1600 to 1700 MeV are reported. These are $K^- + p \rightarrow \Lambda + \pi^0$, $K^- + n \rightarrow \Lambda^0 + \pi^-$, $K^- + n \rightarrow \Lambda^0 + \pi^- + \pi^0$, $K^- + n \rightarrow \Lambda^0 + \pi^- + \pi^+$, $K^- + n \rightarrow \Sigma^+ + \pi^- + \pi^-$, $K^- + D \rightarrow \Lambda^0 + p + \pi^-$, $K^- + D \rightarrow \Lambda^0 + p + \pi^- + \pi^0$, and $K^- + D \rightarrow \Lambda^0 + n + \pi^- + \pi^+$. (B.G.D.)

7466 (PPAD-601F) ELASTIC SCATTERING OF K^+ MESONS BY ^{9}Be AT 950 MeV/c. Murphy, Frederick V. Jr. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Sept. 1966. Contract AT(30-1)-2137. 108p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

A velocity-selecting Cherenkov counter in a 950 MeV/c 13° beam at the Princeton-Pennsylvania Accelerator identified K^+ mesons, which then interacted in ^{9}Be targets in a thin plate spark chamber. Photographs of the scattering were automatically scanned and digitized by a flying-spot cathode ray tube controlled by a PDP-1 computer. The spark coordinates were used to identify and reconstruct 4,000 nuclear elastic scatterings. The differential cross section was fit by a nuclear optical model, assuming a modified Gaussian shape, with a complex repulsive potential $U = (+5 \pm 5)$ MeV $- i\,(28 \pm 3)$ MeV. The volume integral of this potential agrees well with a prediction from the K^+–nucleon forward scattering amplitudes computed from the T = 1 s-wave and p-wave phase shifts known at this momentum and from the T = 0 s-wave and p-wave phase shifts extrapolated from measurements up to 812 MeV/c. This suggests that the T = 0 and T = 1 S = +1 K–nucleon scattering is still dominated by s-waves and p-waves at 950 MeV/c. (auth)

7467 (UCRL-16877) A STUDY OF RESONANCE PRODUCTION AND DECAY AND ELASTIC SCATTERING IN π^-p TWO-PRONG INTERACTIONS, 2.05 TO 3.22 GeV/c. Jacobs, Laurance David (California Univ., Berkeley. Lawrence Radiation Labs.). Aug. 16, 1966. Contract W-7405-eng-48. 199p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

An analysis of 45,000 π^-p interactions in the Alvarez 72-inch hydrogen bubble chamber resulting in two charged particles is presented. The reactions $\pi^-p \rightarrow n\pi^+\pi^-$ and $\pi^-p \rightarrow p\pi^0\pi^-$ and elastic scattering were studied at 2.05, 2.17, 2.36, 2.60, 2.86, and 3.22 GeV/c. The three-body interactions were found to be domi-

nated by production of the ρ meson. Nucleon resonances, although present, are not important. The f^0 is seen at the three higher energies. The OPE model, modified by absorption, was used to calculate and fit the production and decay angular distributions of the ρ and to estimate the s-wave contribution to $\pi\pi$ scattering. On the basis of the model and the observed $(F - B)/(F + B)$ asymmetry in the $\pi^+\pi^-$ state, good agreement with the experimental data in the ρ region is found, if δ_0^0 is allowed to increase slowly through $\pi/2$. A resonant isoscalar s-wave amplitude was not required. The diffraction peak in π^-p elastic scattering was fitted to an exponential form and it was found that between 2.0 and 2.5 GeV/c the exponential slope varies. This behavior is linked to the presence of resonances in the s channel. The fast decrease of the secondary peak is linked to the exchange of the P′ Regge trajectory in the t channel. Evidence is shown for production of the A_2^- in $\pi^-p \rightarrow \pi^-p$ + missing mass. (auth)

7468 TWO-BODY CHANNELS IN THE INTERACTIONS OF 3, 3.5, AND 5 GeV/c POSITIVE KAONS ON HYDROGEN: POSSIBILITY OF REGGE-POLE EXCHANGE. Goldschmidt-Clermont, Y. (CERN, Geneva); Henri, V. P.; Jongejans, B.; (and others). Nuovo Cimento (10), 46A: 539-44(Dec. 1, 1966).

A systematic study was made of two-body and quasi-two-body reactions of 3-, 3.5-, and 5-GeV/c K^+ mesons in the Saclay 81-cm hydrogen bubble chamber. Cross sections for the reactions $K^+p \rightarrow K^+p$, $K^+p \rightarrow K^{*+}p$, $K^+p \rightarrow K^0N^{*2+}$, and $K^+p \rightarrow K^{*0}N^{*2+}$ are studied as functions of center-of-mass energy and momentum transfer squared, and comparisons are made with predictions of the peripheral model. It is concluded that all four reactions are characterized by strong peripheral production; and that they exhibit a shrinking which, within statistics, may be qualitatively described by the simplest Regge-pole model. (L.B.S.)

7469 A DETERMINATION OF THE $K_S - K_L$ MASS DIFFERENCE VIA THE STRANGENESS OSCILLATION TECHNIQUE. Chang, C. Y. (Syracuse Univ., N. Y.); Bassano, D.; Kikuchi, T.; Dodd, P.; Leitner, J. Phys. Lett., 23: 702-6(Dec. 19, 1966).

The time dependence of $\bar{K}^0$ interactions coming from a pure $\bar{K}^0$ beam at $t = 0$ is analyzed for the $K_S - K_L$ mass difference, Δm. The result is in good agreement with recent less accurate measurements using the same technique, as well as more accurate measurements using different techniques. (auth)

7470 EVIDENCE FOR $\pi^+\pi^-$ RESONANCE AT 1.5 to 1.6 GeV IN 4.7 GeV/c π^-p^- INTERACTION. Guzhavin, V. M.; Kliger, G. K.; Kolganov, V. Z.; Lebedev, A. V.; Lomkatsi, G. S.; Smolyankin, V. T.; Sokolov, A. R.; Vetlitsky, I. A. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett., 23: 719-20 (Dec. 19, 1966).

Among 60,000 pictures obtained by means of 55 cm hydrogen bubble chamber exposed with 4.7 GeV/c π^- beam 349 events of the reaction $\pi^-p \rightarrow \pi^+\pi^-n$ at small four mementum transfer have been selected. The distribution of the effective mass of $\pi^+\pi^-$ system shows ρ^0-, f^0- resonances and some enhancement at 1.5 to 1.6 GeV that may be interpreted as a resonance with $M = 1549 \pm 30$ MeV, $\Gamma = 100 \pm 25$ MeV. (auth)

7471 THE STUDY OF THE A_2-MESON PROPERTIES IN THE π^-p-INTERACTIONS AT THE INCIDENT π^--MESONS MOMENTUM 3.25 GeV/c. Dubovikov, M. S.; Grigorev, V. K.; Grishin, A. P.; (and others) (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett., 23: 716-18(Dec. 19, 1966).

Using 55 cm hydrogen bubble chamber exposed in the π^--meson beam at 3.25 ± 0.02 GeV/c 160,000 photographs were obtained and 2104 events of the reactions of the type $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ and 1766 events of the reactions of the type $\pi^-p \rightarrow p\pi^+\pi^-\pi^-\pi^0$ were selected and analyzed. In the spectrum of the effective masses of $\pi^+\pi^-\pi^-$ system from the first reaction A_2-mesons were selected and the analysis was made by means of different methods to determine the spin-parity of this resonance. The second reaction was used to study $\pi\eta$ decay mode of the A_2-meson. (auth)

7472 REACTION $K^- + p \rightarrow K^- + p + \pi^+ + \pi^-$ AT 2.63 AND 2.70 BeV/c. Mortara, David Ward. Urbana, Ill., Univ. of Illinois, 1966. 76p.

Thesis.

An experiment was performed using the 72″ Alvarez hydrogen bubble chamber with incident K^- beams of 2.63 and 2.70 BeV/c. In a film sample of 90,000 frames, 9307 4-prong, zero V^0 events were found and measured on SMP's. The events were fitted using the Berkeley analysis program PACKAGE, and 1857 events were found to have a satisfactory kinematic fit to the reaction $K^-p \rightarrow K^-p\pi^+\pi^-$. This reaction was shown to be dominated by production of several known resonant states. A maximum likelihood fit shows that the final state consists of 32% $N^{*++}K^-\pi^-$, 26% $\bar{K}^{*}p\pi^-$, 12% $\bar{K}^{*}N^{*0}$, and 30% other miscellaneous states. Unexplained asymmetries are observed in the $\bar{K}^{*}$ and N^{*0} decay distributions for the $\bar{K}^{*}N^{*0}$ intermediate state. (auth)

Particle Interactions and Properties (Theoretical)

General

7473 THE DISCONTINUITIES OF THE TRIANGLE GRAPH AS A FUNCTION OF AN INTERNAL MASS. II. Kacser, C. (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.), 7: 2008-25(Nov. 1966).

The discontinuities of the triangle-graph amplitude as a function of an internal mass variable are considered. These discontinuities are important, since they form the kernel of the Aitchison–Anisovich integral equation, which is derived from the Khuri–Treiman three-body final-state-interaction dispersion relation. The discontinuities are evaluated by explicitly performing the Feynman α integrations. Their analytic continuations are also discussed. Finally the applicability of the Cutkosky rules to such an internal mass variable discontinuity is considered. It is argued that these rules must be modified in two ways. One of these is straightforward, having to do with the appearance of spacelike masses. The other is more involved and is a consequence of the results of homology theory. The modified Cutkosky rules are applied to the triangle-graph discontinuities and the same results were obtained as found by the direct method, so confirming the modifications which were made. (auth)

7474 SIZES ASSOCIATED WITH BOSONS AND FERMIONS IN THE PRINCIPLE OF FIVE-DIMENSIONAL GENERAL RELATIVITY. Fliche, H.-H. (Faculte des Sciences, Marseille). Nuovo Cimento (10), 46A: 312-7(Nov. 21, 1966). (In French).

Among the unitary theories, the five-dimensional general relativity gives a geometrical origin to the electromagnetic field and to its action upon charged particles. The active role of a charged particle acting as origin of the electromagnetic field for bosons and fermions is proposed. (auth)

7475 SPIN INDEPENDENCE OF TOTAL CROSS SECTIONS. Hara, Yasuo (Tokyo Univ.). Phys. Lett., 23: 696-8(Dec. 19, 1966).

In the Regge pole model with the Pomeranchuk trajectory dominance, total cross sections of particles with any spin are proved to be spin independent at high energies. The factorizability of total cross sections, $\sigma_{ab}(s)\,\sigma_{cd}(s) - \sigma_{ac}(s)\,\sigma_{bd}(s) \xrightarrow[s\to\infty]{} 0$, is also proved. (auth)

7476 STATISTICAL MODEL CALCULATIONS OF HIGH-ENERGY REACTIONS AND ANALYSIS OF A PROPOSED ANALYTICITY TEST. Campbell, Graham Hays. Berkeley, Calif., Univ. of California, 1965. 96p.

Thesis.

Calculations based on a covariant version of the Fermi statistical model were made in an attempt to fit the known gross features of elementary particle reactions at energies presently accessible to accelerators. An extrapolation of these data to the higher energies of future accelerators was provided. The n-fold phase space integration required for the model was reduced to a single contour integral which was approximated by a saddle point technique. Resonance states were included as final state particles. The initial predictions of this model were not in agreement with experiments and although modifications of the model were found to improve the situation none of these modifications yield a reliable method of extrapolation to higher energy. An analyticity test proposed by Regge and Viano was analyzed under conditions similar to possible applications of the test to experimental data. It was shown that any results of such an application must be inconclusive. The class of functions to which this procedure may be applied was determined. This class may be broadened if partial knowledge of the asymptotic behavior of the functions is available. (Distr. Abstr.)

Electromagnetic

Refer also to abstracts 7450 and 7451.

7477 (AD-633951) SIMPLE RELATIVISTIC CALCULATION OF THE ELECTROMAGNETIC FORM FACTORS OF THE DEUTERON. Dietz, Klaus; Month, Melvin (Illinois Univ., Urbana. Dept. of Physics). 1966. Contract Nonr-1834(05). 1966. CFSTI $3.00 cy, $0.65 mn.

A simple method of extracting anomalous singularities from the electromagnetic vertex function of bound states is proposed. The method was applied to the electromagnetic form factor of the deuteron and its relevance was proven by a thorough comparison with the experimental data. (auth)

7478 (COO-1371-36) PROGRESS REPORT [ON THEORETICAL PHYSICS] FOR PERIOD SEPTEMBER 1, 1965 THROUGH AUGUST 31, 1966. (Minnesota Univ., Minneapolis. School of Physics). Contract AT(11-1)-1371. 43p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A progress report is presented on the experimental and theoretical research activities at the University of Minnesota in high-energy physics and nuclear physics. (B.G.D.)

7479 (JINR-E2-3039) ON THE CURRENT DIVERGENCES. Enkovski, L.; Kukhtin, V. V.; Montvai, I.; Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 6p. Dep. mn.

In the framework of the quark model the divergences of axial and vector hadronic currents are considered taking into account, in the first order, the electromagnetic and weak interactions (semileptonic and nonleptonic). On the basis of these relations for current divergence many consequences of current algebra dealing with the electromagnetic and weak interactions can be derived. (auth)

7480 (JINR-P2-2991) RASSEYANIE ELEKTRONOV NA POLYARIZOVANNYKH ADRONNYKH MISHENYAKH. (Electron Scattering by Polarized Hadron Targets). Dubovik, V. M.; Cheshkov, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 19p. (In Russian). Dep. mn.

The cross section for electron-hadron scattering $e + N \rightarrow e + N'$ is calculated in the one-photon approximation. It is supposed that the target particle N has spin j and mass κ and a newly produced particle N'-spin j and mass κ'. All transition electromagnetic form factors are taken into account. The spin state of target particles is considered to be arbitrary and expressed in terms of the density matrix in the form of an expansion in irreducible spherical tensors. The selection rules of form factors are given under P- and T-invariance requirements. The contribution of T-noninvariant form factors to the cross section is discussed. Some important particular cases are obtained from the general cross section formula. (auth)

7481 (JINR-P2-3062) SKHEMA VOSSTANOVLENIYA AMPLITUDY PROTSESSOV $eN \rightarrow eN\,\pi\,I\,\pi\,N \rightarrow Ne^-e^+$ PO DANNYM OPYTA. (Reduction Scheme of the Amplitude for the Processes $eN \rightarrow eN\,\pi$ and $\pi N \rightarrow Ne^-e^+$ by the Experimental Data). Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 11p. (In Russian). Dep. mn.

A scheme is given of a complete experiment for the processes $eN \rightarrow eN\pi$ and $\pi N \rightarrow Ne^-e^+$. The formulas are obtained which express the amplitudes, describing the above-mentioned processes, by the measured values. (auth)

7482 RESOLUTION OF THE DISPERSION RELATIONS OF PHOTOPRODUCTION. Mennessier, G. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cimento (10), 46A: 459-83(Dec. 1, 1966).

Dispersion relations are derived for the 3-3 partial-wave amplitudes of photoproduction, assuming the dominance of the I^* in the contribution to the imaginary parts of the amplitudes. The Omnès method to solve the equations is discussed, and a particular solution is chosen. Some corrections to the Born approximation are evaluated at the end for nonresonant isovector multipoles. (auth)

7483 IMPLICATIONS OF THE OBSERVED ELECTROMAGNETIC MASS SPLITTINGS FOR THE QUARK MODEL. Barton, G.; Dare, D. (Univ. of Sussex, Brighton, Eng.). Nuovo Cimento (10), 46A: 433-7(Dec. 1, 1966).

Observations suggest i) that in the baryon and pseudoscalar octets magnetic energies are not negligible, whence the quark's charge and magnetization are likely to be roughly as diffuse as the nucleon's; and ii) that either the quark motion is essentially relativistic at least in the baryons, or charge-dependent corrections to the strong quark-quark forces are important. (auth)

7484 UNUSUAL ELECTRODYNAMICS OF A PARTICLE WITH ONE-HALF SPIN. Goldman, I. I. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 1: 207-16(1966). (In Russian).

An analysis is made of the unusual way of introducing electromagnetic interaction into the Dirac equation. The study proceeds from the observation on the occurrence of three-parameter group transformations which leave the Dirac free equation invariant. These transformations assume the form of $\psi = a\psi + b\psi^{(c)}$ where the complex numbers a, b satisfy the condition $|a|^2 - |b|^2 = 1$. This noncompact group contains the usual phase transformation as well as the one-parameter group of transformations with real a, b, which are used for the introduction of electromagnetic interaction. This formalism is invariant with respect to gauge transformations. Particles with such interaction must possess charge and magnetic moment equal to zero; however, the cross section of pair production of such particles is of the same order of magnitude as in usual electrodynamics. (auth)

7485 ON C-VIOLATION IN PHOTOPRODUCTION OF PIONS AND IN PROTON COMPTON SCATTERING. Hadjioannou, F. T.; Iliopoulos, J.; Mennessier, G. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cimento (10), 46A: 281-90 (Nov. 21, 1966).

The possible C-violation in low-energy photoproduction of pions and in proton Compton scattering is investigated. C-violation is introduced in the isobaric model and compared with experiment. Near the I^* resonance region an assumption of maximal C-violation in photoproduction fails badly, however at lower energies the violation can be important and still compatible with the experimental results on the angular distributions. The effects on Compton scattering, even under maximal violation, are very small to be detected with the present experimental possibilities. (auth)

Weak

Refer also to abstract 7479.

7486 SOME RARE DECAY MODES AND THE ALGEBRA OF CURRENTS. Mohanti, A. K. (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 46A: 554-7(Dec. 1, 1966).

The application of the algebra of currents and PCAC to soft-pion processes is investigated. The method is summarized for the case of processes differing by one pion and is applied to calculate branching ratios of some rare decay modes. (L.B.S.)

7487 ON THE ASSUMPTION OF A SPONTANEOUS BREAKDOWN OF SYMMETRY IN THE LEPTONIC DECAYS OF K-MESONS. Pinter, Gyoergy; Suranyi, Peter; Toth, Kalman. Magyar Tud. Akad. Kozp. Fiz. Kut. Int. Kozlem., 14: 193-6(1966). (In Hungarian).

The deviation from the exact SU(3) symmetry may be due either to a medium strong interaction or to an internal, spontaneous breakdown of symmetry. In the latter case a simple energy dependence should describe the relation between the form factors of the K_{l3} decays, which, however, does not agree with the energy dependence observed experimentally. It is possible, on the other hand, that this is not in contradiction with a spontaneous breakdown of symmetry but with the assumed nature of the hadron weak current. (auth)

7488 SOME PROCESSES OF FORMATION OF THE INTERMEDIATE VECTOR MESON. Rekalo, M. P. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 11: 1056-64(Oct. 1966). (In Ukrainian).

Some processes of formation of the intermediate vector meson are considered: photo-formation of the W-meson on a proton, formation of the W-meson together with a π-meson with (e^+e^-) and ($p\bar{p}$) anihilation. The general features of these processes are as follows; sections of all three processes at large energies of colliding particles tend to certain constant values, for products of the decay of the forming W-meson $W \rightarrow 2\pi$, $W \rightarrow k + \pi$ there arise correlations, which do not retain parity, that can be used for distinguishing the processes under discussion, the angular distribution of W-mesons from the reactions $\bar{p} + p \rightarrow \pi + W$, $\gamma + p \rightarrow n + W^+$ in the pole approximation is of specific nature which may permit distinguishing the contribution of the pole diagram. (auth)

7489 WEAK INTERACTIONS AND NUCLEAR BETA DECAY. Schopper, Herwig F. Amsterdam, North-Holland Publishing Co., 1966. 425p. $15.40; 55 Guilders.

The theory of weak interactions is developed on the basis of conventional ideas. Topics discussed include conservation laws, phenomenological formulation of β interaction, classification of decays and selection rules, classical β decay experiments, nonconservation of parity and charge conjugation, the neutrino, decay of mesons and strange particles, weak interaction theories, beta decay and nuclear spectroscopy. Included in the appendices are the Dirac equation, relations between particle and antiparticle decays, the β interaction with lepton nonconservation, isospin formalism, exact Coulomb functions and useful relations in weak interaction theory. (C.E.S.)

Strong (General)

7490 (UCRL-14498-T) DOUBLE BOOTSTRAPS. Alexanian, Moorad; Nath, Pran; Srivastava, Y. N. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 6, 1965. Contract W-7405-eng-48. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The consequences of the connection between Reggeness and the vanishing of the renormalization constants as dynamical criteria,

which is of interest in various bootstrap models, are investigated. (B.G.D.)

7491 (UCRL-14518-T) STRONG INTERACTIONS IN THE LIMIT $Z_3 = 0$. Zimmerman, Robert L. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 28, 1965. Contract W-7405-eng-48. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The derivation of a Lagrangian density $L_M(\Psi,\bar{\Psi})$ which is a function of only the fermion and anti-fermion fields and contains a boson as a bound state at mass μ is presented. It is also required that $L_M(\Psi,\bar{\Psi})$ be equivalent to a theory with a Yukawa coupling plus a Matthews term in the limit that the wave function renormalization constant Z_3 vanishes. First the case where the Matthews term is neglected is considered, and it is shown that $L_\phi(\Psi,\bar{\Psi})$ is just the usual four-fermion theory. In the case where the Matthews term is not neglected $L_\phi(\Psi,\bar{\Psi})$ is derived in the case of strong coupling and weak coupling. The Lagrangian density is a highly nonlinear function of the fermion fields which in the weak coupling limit reduces to the four-fermion theory as the Matthews term vanishes. (auth)

7492 STRONG COUPLING THEORY OF A CHIRAL FOUR FERMION INTERACTION. Ichimura, Munetake (Nihon Univ., Tokyo); Kikkawa, Keiji; Yazaki, Koichi. Progr. Theoret. Phys. (Kyoto), 36: 820-41(Oct. 1966).

The theory of the strong coupling limit is developed for the chiral four fermion interaction $L_{int} = -g_0\{(\bar{\psi}\psi)^2 - (\bar{\psi}\gamma_5\psi)^2\}$ using the same approximation as in the superconductor model of elementary particles proposed by Nambu and Jona-Lasinio. The validity of their model is studied. The physical meaning of their model is clearly interpreted. In particular, the state vectors of their model are interpreted as wave packets in the space of the phase which is canonically conjugate to the chirality; the packets spread out in the short time 1/m even in the limit of infinite normalization volume. This fact seems to contradict the usual belief that the Nambu-Jona-Lasinio treatment becomes exact in the limit of infinite normalization volume. The strong coupling theory is then extended to an SU(3) invariant model. It asserts that it is the symmetric solution (with a finite fermion mass) which should be physical rather than the spontaneous SU(3)-symmetry-breaking solutions. A very detailed comparison is also carried out between the Numbu-Jona-Lasinio theory and the strong coupling theory in the limit of infinite volume. (auth)

7493 CLASSIFICATION OF AN UNSTABLE PARTICLE AND ITS PROPAGATOR. Uehara, Masayuki (Univ. of Osaka Prefecture). Progr. Theoret. Phys. (Kyoto), 36: 781-98(Oct. 1966).

The classification of an unstable particle according to the values of the complex wave function renormalization constant is discussed. The propagator of the unstable particle is analytically continued to an unphysical Riemann sheet, on which there exist poles of the propagator corresponding to the unstable particle. The complex renormalization constant is defined as a limiting value of the unphysical propagator at high energies. Equations to determine the complex coupling constant and the complex mass are obtained. The classification thus obtained is similar to the case of a stable particle. Extension to the multi-channel formalism is also discussed. (auth)

7494 THE SOLUTION OF A STARK-EFFECT MODEL AS A DYNAMICAL GROUP CALCULATION. Flamand, G. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). J. Math. Phys. (N. Y.), 7: 1924-31(Nov. 1966).

A model for the Stark mixing of orbital states in the annihilation of particles at rest is solved by using the dynamical group techniques. The Schrödinger equation for the problem is given meaning in a representation of the three-dimensional rotation group and reduced to a two-dimensional linear homogeneous differential equation. (auth)

7495 SOME CROSSING MATRICES AND POSSIBLE SELF-CONSISTENT MULTIPLETS IN SU_n. Hopkinson, J. F. L. (Imperial Coll. of Science and Tech., London). Nuovo Cimento (10), 46A: 318-27(Nov. 21, 1966).

The usual arguments for determining from the crossing matrix which multiplets of a symmetry group may bootstrap themselves are summarized. A number of crossing matrices for the group SU_n are presented, and these arguments applied to them. It is concluded that the usual meson and baryon multiplets can, in general, bootstrap themselves, though for special cases extra multiplets may be needed. (auth)

7496 SOME REMARKS ABOUT COVARIANCE AND EQUAL-TIME COMMUTATORS OF QUARK CURRENTS. Loubaton, J. P.; Mennessier, G. (Faculte des Sciences, Orsay, France). Nuovo Cimento (10), 46A: 328-36(Nov. 21, 1966).

It is shown that sum rules obtained by commutation of space components of currents are not covariant. This is reinterpreted as an indeterminacy related to the nonunique splitting of the derivative of a retarded commutator. (auth)

Strong (Baryon No. = 0)

7497 (JINR-P2-3001) STATISTICHESKAYA UNITARNO-SIMMETRICHNAYA TEORIYA ANNIGILYATSIONNYKH PROTSESSOV. (Statistical Theory With Breaking Unitary Symmetry for Annihilation Processes). Barashenkov, V. S.; Zinov'ev, G. M.; Mal'tsev, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 8p. (In Russian). Dep. mn.

A statistical model with breaking unitary symmetry is proposed. The results of calculations, performed for the $p\bar{p}$-annihilation case, are close to the experimental ones. An essential disagreement is seen only for the relative probabilities of channels with a small number of particles. (auth)

7498 MASS FORMULA FOR HIGHER BOSON RESONANCES. Akiba, Tomoya (Tohoku Univ., Sendai). Progr. Theoret. Phys. (Kyoto), 36: 842-3(Oct. 1966).

An L-dependent mass splitting in the (3S,L) boson resonances was examined within the framework of Gell-Mann's argument on the orbital angular momentum of quarks. (L.B.S.)

7499 FUBINI SUM RULE AND ANALYTICITY IN ANGULAR MOMENTUM PLANE. Singh, Virendra (Rockefeller Univ., New York). Phys. Rev. Lett., 18: 36-9(Jan. 2, 1967).

The analyticity in angular momentum plane of the definite helicity amplitudes for the process $\pi + \pi \to \gamma_\alpha + \gamma_\beta$ was studied. The study was restricted to I = 1 T-channel (i.e., $\pi + \pi \to \gamma_\alpha + \gamma_\beta$) amplitude only. For simplicity $K_1^2 = K_3^2 = 0$ was assumed. (B.G.D.)

7500 MESON-MESON SCATTERING IN THE QUARK MODEL AND THE ADLER SUM RULE. Chiu, Y. T.; Schechter, J. (Univ. of Chicago). Nuovo Cimento (10), 46A: 548-51(Dec. 1, 1966).

Relations among the cross sections for meson-meson scattering are obtained using the additive quark model. The relations provide a means of estimating the high-energy behavior of the integrals that appear in the Adler-Weisberger type of sum rules. The result supports the previous conclusion that the π-π and π-K sum rules are far from saturated by well-established resonances. (L.B.S.)

7501 REMARKS ON THE REGGE TRAJECTORIES. Minami, S. (Osaka City Univ.). Nuovo Cimento (10), 46A: 545-7(Dec. 1, 1966).

An attempt is made to describe the observed meson resonances and to predict new resonances on the basis of the following assumption: the mesons with spin J specified by J = L + 1 belong to a straight-line trajectory ($^3L_{J=L+1}$ trajectory). The $^1L_{J=L}$ trajectory is also examined. Regge trajectories of the baryon family are briefly discussed under the assumption of exchange degeneracy. (L.B.S.)

7502 INELASTIC INTERACTIONS OF PARTICLES AT HIGH ENERGIES. I. THE COMPOSITION AND MULTIPLICITY OF SECONDARY PARTICLES. Barashenkov, V. S.; Maltsev, V. M.; Patera, I.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Fortschr. Phys., 14: 357-99(1966).

Experimental data on multiple particle production in inelastic interactions in the high-energy region T ≳ GeV are collected and analyzed. The special case of antinucleon annihilation is also considered since many fast secondary particles can be produced even at very low energy. The review treats one of the main characteristics of inelastic interactions: the distribution of inelastic interactions over the multiplicity of particles produced; the composition of secondary particles. Two types of distributions are considered: the distribution over the total number of particles produced and the distribution over the number of star-prongs observed. Data on probabilities of three-particle reactions (for example $p + p \to p + n + \pi^+$ or $\pi^- + p \to n + \pi^+ + \pi^-$) and two-meson annihilation are also presented. (L.B.S.)

7503 CONNECTION BETWEEN THE FERMI MODEL AND THE LOW THEORY. Yamamoto, Y. (Tokyo Univ.). Nuovo Cimento (10), 46A: 519-28(Dec. 1, 1966).

The connection between the Low theory and the Fermi model is discussed. It is shown that the former corresponds to the production of mesons by a single source while in the latter mesons are emitted by several independent sources and are in thermal equilibrium. The difference between these models can be seen in the fluctuation of the multiplicity. (auth)

7504 δ^- PRODUCTION IN A REGGE POLE AND L-EXCITATION SCHEME MODEL. Sutherland, D. G. (CERN, Geneva). Nuovo Cimento (10), 46A: 552-3(Dec. 1, 1966).

The δ^- production was investigated in a simple Regge pole

model and an estimate of the cross section was found to be ~4 to 13 μb. (auth)

7505 BOOTSTRAP OF THE $\pi-\pi$, J = 0, T = 0, ANTIBOUND STATE. Banyai, L.; Marinescu, N.; Rittenberg, V. (Inst. of Physics, Bucharest). Nuovo Cimento (10), 46A: 558-62(Dec. 1, 1966).

A bootstrap calculation is made of the $\pi-\pi$, J = 0, T = 0 antibound state using a method in which crossing symmetry and analyticity are taken into account exactly, but unitarity approximately. It is found that the antibound state can neither be self-sustained nor can be determined by the presence of the ρ meson in the crossed channel. A solution is obtained when a J = 0, T = 0 resonance is considered, and plausible values for the scattering length are then obtained. (L.B.S.)

7506 CONSISTENCY OF CURRENT COMMUTATION RELATIONS AND RELATED CONSIDERATIONS. Chang, S. J.; Nieh, H. T.; Yan, T. M. (Harvard Univ., Cambridge, Mass.). Nuovo Cimento (10), 46A: 364-9(Nov. 21, 1966).

Okubo recently proved the inconsistency of the commutation relation, $[j_0(x), j^0(x')] = 0$, for any local Lorentz vector $j_\mu(x)$. In his proof, use is made of the assumption that there are no massless excitations in the physical spectrum. An elementary observation reveals, however, that this assumption is really not necessary. The PS–PV meson theory and the σ-model are discussed. With a proper definition for the current as localized field operator product, the formal inconsistencies observed by Okubo in these two theoretic models are resolved. (auth)

7507 MODEL FOR ELASTIC SCATTERING AT HIGH ENERGY AND LARGE MOMENTUM TRANSFER. Contogouris, A. P. (Faculte des Sciences, Orsay, France). Phys. Lett., 23: 698-701(Dec. 19, 1966).

A model is presented, in which the variation of the differential cross section at large momentum transfer is determined in terms of experimentally known quantities. (auth)

7508 ANNIHILATION AND CHARGE EXCHANGE IN $\bar{p}p$ SCATTERING AT HIGH ENERGIES. Bialas, A. (Jagellonian Univ., Krakow); Zalewski, K. Nuovo Cimento (10), 46A: 425-9(Nov. 21, 1966).

The overlap matrix formalism without the simplifying assumption that the overlap matrix is diagonal is used to investigate high-energy $p\bar{p}$ scattering with charge exchange singled out from the inelastic channels. The effect of the strong annihilation channels on the $p\bar{p}$ charge exchange is considered. This approach seems to provide a qualitative explanation of the small slope of the forward $p\bar{p} \to n\bar{n}$ peak. (C.E.S.)

7509 QUARK MODEL DECAY RATES FOR SPIN 2^+ MESONS. Rubinstein, H. R.; Talmi, I. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Lett., 23: 693-5(Dec. 19, 1966).

Both PP and PV decays can go only through symmetry breaking. An appropriate tensor interaction is introduced which is different for different quark-antiquark pairs. Agreement with experiment is good. (auth)

7510 POSSIBLE REGGE RECURRENCES OF THE VECTOR AND TENSOR MESONS. Ahmadzadeh, A. (Arizona State Univ., Tempe). Nuovo Cimento (10), 46A: 415-18(Nov. 21, 1966).

The exchange degeneracy classification of the trajectories given earlier is used here to suggest that the new meson (L-meson) recently discovered by Bartsch et al. may have spin-parity 3^-. It is also shown that the masses of new enhancements attributed by Cline to the ρ and R trajectories agree very well with the exchange degeneracy classification. Further prediction of isospin-zero resonances is also given. (auth)

7511 POSSIBLE REGGEIZED BOOTSTRAP THEORY. Abbe, Winfield Jonathan. Riverside, Calif., Univ. of California, 1966. 157p.

Thesis.

A set of equations (bootstrap equations) from which it may be possible to self-consistently calculate the known resonances is formulated and tested within the framework of two-body unitarity. The resulting equations are written in terms of Regge trajectories only; all parameters are to be determined by some approximate satisfaction of the crossing relations. The study proceeds in three basic stages. First, a recent representation of the partial-wave S-matrix given by Cheng was used. This representation was modified so as to obtain rapid convergence to the exact S-matrix in terms of trajectories. The resulting representation, called the Modified Cheng Representation, has the following properties regardless of the number of trajectories included: it is unitary for all l and s > 0; it has the correct threshold behavior; it reproduces the correct analytic properties of the total amplitude in the cos θ -plane; and in an actual numerical test, it converges rapidly. The second stage consists in using the Modified Cheng Representation to construct a total scattering amplitude which has the following properties: it has the correct analytic structure for all z and s > 0; no approximations on the background integral are made; the corresponding double spectral function has the correct curved boundary; and in an actual numerical test, it converges rapidly. The third stage consists in extending the above equations to the relativistic case, thereby constructing bootstrap equations. The extension is made by assuming more general forms for the trajectories; a reasonable extension results in a representation that is conjectured to hold for relativistic problems. This is then used to construct a total scattering amplitude, which through the crossing relation, allows one to construct bootstrap equations. No dispersion integrals need be performed, and all statements are exact up to the first inelastic threshold, if the S-matrix is. The full background integral is retained. Several applications are made. It is shown that the infinitely many trajectories streaming into $l = -\frac{1}{2}$, can give a sizable contribution to the S-matrix, although each trajectory gives a zero-contribution. The Modified Cheng Representation, which was derived on the basis of potential theory, and conjectured to hold for relativistic problems, is shown to actually give results that agree rather well with experiment when applied to pion-nucleon scattering. A phenomenological bootstrap calculation of the rho-meson is performed. The I = 0 channel is included, and no approximations are made with respect to the I = 2 channel. Although the position of the rho mass is left inconclusive, a width lying between 75 and 125 MeV was found to be in good agreement with the experimental value of 106 MeV. (Distr. Abstr.)

Strong (Baryon No. = 1)

Refer also to abstract 7460, 7501, 7502, and 7507.

7512 (JINR-P2-3054) O VYVODE URAVNENII CHU-LOU I PROISKHOZHDENII FUNKTSII OBREZANIYA V STATICHESKIKH MODELYAKH. (On a Derivation of Chew-Low Equations and the Origin of Cutoff Function in Static Models). Meshcheryakov, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 15p. (In Russian). Dep. mn.

A method is suggested to derive Chew–Low equations from the Mandelstam representation. The meaning of the cutoff function in static models is cleared up. It takes into account the partial wave cut from the third channel. It is shown that this function can also be considered as an account of inelastic processes in two first channels. (auth)

7513 (NP-16398) REMARKS ON CALCULATIONS OF MASS SHIFTS BY THE N/D METHOD. Banerjee, Haridas (Saha Inst. of Nuclear Physics, Calcutta (India)). [1966]. 18p.

The validity of the N/D approximation method recently followed by Dashen and Frautschi in calculating mass shifts (response) of bound and resonant states in the direct channel due to variations of the masses of exchanged particles is examined. Two models are considered which in the usual N/D approximation reproduce the essential features of the dynamical model considered by Dashen and Frautschi, viz., a simple pole in the unphysical region of the complex energy plane, partial-wave analyticity, and elastic unitarity. In either case the sign of the response obtained by the method of Dashen and Frautschi implies the presence of ghosts in the theory and is opposite to what one gets for the exact result. This discrepancy is attributed to the inadequacy of the approximation (in the N/D method) of the "potential" singularities of the scattering amplitude by those of the first Born term. (auth)

7514 BARYON RESONANCES IN A QUARK MODEL. Ida, Masakuni; Kobayashi, Reido (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 36: 846-7(Oct. 1966).

A specific quark model is considered for low-lying baryon resonances in which the baryons consist of a qq pair (or diquark) and another quark moving around it with orbital angular momentum L. SU(6) is regarded as an approximate dynamical symmetry respected by states with L = 0. An octet Regge trajectory with the $\frac{1}{2}^+$ octet as its starting resonance and a decuplet Regge trajectory with the $\frac{3}{2}^+$ decuplet as its starting member are obtained in the limit of exchange degeneracy. The classification of baryon resonances is summarized. (L.B.S.)

7515 REACTION $\pi(K) + p \to \pi(K) + N^*$ AND THE ONE-PARTICLE EXCHANGE MODELS. Bialas, A.; Kotanski, A. (Jagellonian Univ., Krakow). Acta Phys. Pol., 30: 833-8(Nov. 1966).

The polarization of the nucleon (3,3) resonance produced in the reaction $\pi(K) + p \to \pi(K) + N^*$ is investigated. It is shown that the measurement of the angular distribution of the N^* decay can provide information on the relative phases of the helicity amplitudes in that process. This information can therefore be used as

a general test for the applicability of the one-particle and/or Regge-pole exchange models which predict equal phases of all helicity amplitudes. The test is independent of any details of the considered model (like e.g., the values of coupling constants or the shape of formfactors, absorption factors or vertex functions). (auth)

7516 COMPARISON OF RECENT PION–NUCLEON PHASE-SHIFT ANALYSES. Roper, L. David (Kentucky Southern Coll., Louisville). Fortschr. Phys., 14: 305-15(1966).

Comparison is made of recent pion-nucleon phase shift analyses in the 300- to 700-MeV energy range, using an energy-dependent method. χ^2 results are presented for solutions with the S_{11} resonance, P_{11} resonance, and both resonances. (L.B.S.)

7517 RESONANCES FROM THE REACTIONS $\pi N \rightarrow \pi\pi N$ IN THE s CHANNEL. Courau, A. (College de France, Paris). Nuovo Cimento (10), 46A: 291-311(Nov. 21, 1966). (In French).

An inelastic model with isobar in the s channel is proposed: it is called a multi-isobaric model and it is considered to be the predominant process in the production of one π in the range of the first isobars following the reactions $\pi p \rightarrow N^* \rightarrow \pi\Delta\ (^3/_2{}^3/_2{}^+)$, $\Delta \rightarrow \pi N$. These diagrams are analysed in an original method and compared with the peripheral ρ-exchange model. For incident π of 900 MeV and 1300 MeV, a fairly good fit to experimental results was obtained. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 7502 and 7507.

7518 (BNL–9600) ON THE 1.40 GeV MAXIMUM IN p–p INELASTIC SCATTERING. Resnick, L. (Brookhaven National Lab., Upton, N. Y.). Oct. 1965. Contract AT(30-2)-Gen-16. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Drell–Hüda model, in which the incident proton diffraction scatters off a virtual pion in the cloud of the target proton putting it on the mass shell, is suggested as a possible mechanism for explaining the energy and angle dependence of the 1.40 GeV bump observed in recent high energy p-p experiments. (B.G.D.)

7519 (JINR–P2-3005) MNOGOCHASTICHNYI MEKHANIZM VZAIMODEISTVIYA KOSMICHESKOGO IZLUCHENIYA S ATOMNYMI YADRAMI. (Many Particle Mechanism of Interaction of Cosmic Rays With Atomic Nuclei). Artykov, I. Z.; Barashenkov, V. S.; Eliseev, S. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 8p. (In Russian).

Interactions of nucleons with photoemulsion nuclei are calculated for the energies of 6 to 1000 GeV. Many-particle cascade interactions inside the nuclei are taken into account. The results of calculations are compared with the experimental data. (auth)

7520 ON THE QUESTION OF CHARGE SYMMETRY IN D–D REACTIONS. Yu, David U. L. (Stanford Univ., Calif.). Contract AF 49(638)-1389. Progr. Theoret. Phys. (Kyoto), 36: 734-44(Oct. 1966).

The question of charge symmetry in D-D reactions is discussed in light of the recently discovered virtual excited states of the alpha particle. Their effects on the asymmetries in the angular distributions as well as the provision of a mechanism for p-wave enhancement are pointed out. Relation with three-nucleon isobars is also discussed. (auth)

Particle Invariance Principles and Symmetries

General

7521 (JINR–E2-2982) QUANTUM NUMBERS IN THE LITTLE GROUPS OF THE POINCARE GROUP. Lukach, I.; Smorodinskii, Ya. A.; Winternitz, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 15p. Dep. mn.

Integrals of motion and quantum numbers in the groups 0(3), 0(2,1) and E_2 are considered. It is shown that an integral of motion, expressed as a homogeneous hermitian operator, quadratical in the generators of the corresponding group, corresponds to each coordinate system in which the Laplace equation separates. Any operator of the mentioned type is equivalent to one of the discussed polynomials. (auth)

7522 (JINR–E2-3006) CURRENT-FIELD EQUAL-TIME COMMUTATION RELATIONS. Byalynitskii-Birulya, I.; Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 6p. Dep. mn.

The U(6) ⊗ U(6) group is constructed on the basis of the current algebra without intrinsic contradictions. In contrast to the method of Gell–Mann et al., the SU(6) group is here a transformation group of the field operators. (auth)

7523 (JINR–P2-3007) UNITARNAYA STATISTICHESKAYA MODEL' MNOZHESTVENNOGO ROZHDENIYA CHASTITS. (Unitary Statistical Model of Multiple Particle Production). Barashenkov, V. S.; Zinov'ev, G. M.; Mal'tsev, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 6p. (In Russian). Dep. mn.

A statistical SU_3 breaking symmetry model is discussed. The results of calculations agree well with experiment. Disagreement is seen only for interactions with a small number of particles produced. (auth)

7524 (N–66-28309) EXPERIMENTALIST'S VIEW OF SU_3. Leitner, Jack (Syracuse Univ., N. Y.). 1966. Contract Nonr-669(12). 37p. (ONR–66-1; AD–631704). CFSTI $3.00 cy, $0.65 mn.

A general review of the extent of the agreement between SU(3) and experiment is presented. It is stated that some confusion exists between those who emphasize the apparent successes of this theory and those who point out its apparent failures. One of the reasons given for this state of confusion is that SU(3) is a theory of approximate symmetry where the strong hamiltonian is not entirely invariant under appropriate transformations. It is pointed out that the organization of the catalog of SU(3) is a compromise between logical development and historical emphasis. This catalog includes: classification of mesons and baryons, electromagnetic properties of baryons and mesons, production rates of baryons and mesons, leptonic weak interactions, and nonleptonic decays. A discussion of each of these considerations is included. (STAR)

7525 IRREDUCIBLE REPRESENTATION OF A CLASS OF ALGEBRAS AND RELATED PROJECTIVE REPRESENTATIONS. Barut, A. O. (Univ. of Colorado, Boulder). J. Math. Phys. (N. Y.), 7: 1908-10(Nov. 1966).

The number and the dimensions of irreducible representations of a general class of algebras occurring in the projective representations of finite groups were determined. The Lie subalgebras were found, and the isomorphism between the quantum-mechanical ray representations of finite groups and the fundamental representations of Lie algebras is shown. (auth)

7526 UNITARY AND ANTIUNITARY RAY REPRESENTATIONS OF THE PRODUCT OF n COMMUTING PARITY OPERATORS. Barut, A. O.; Komy, S. (Univ. of Colorado, Boulder). J. Math. Phys. (N. Y.), 7: 1903-7(Nov. 1966).

The unitary and antiunitary ray representations of the group of n commuting operators Γ_i, $i = 1, 2, \ldots, n$, satisfying $\Gamma_i^2 = 1$, $\Gamma_i\Gamma_j = \Gamma_j\Gamma_i$, have been determined explicitly. The ray representations are shown to be homomorphic to the representations of a class of generalized Clifford algebras defined in the text. The enumeration of different algebras gives a complete classification of inequivalent ray representations. Whereas the irreducible vector representations of the group are all one-dimensional, the irreducible ray representations lead to various multiplet structure of states ranging in dimensions from 1 to $2^{\frac{1}{2}n}$ (n even), or $2^{\frac{1}{2}(n-1)}$ (n odd), in powers of two. The arbitrary antiunitary case can be reduced to the case can be reduced to the case with only one antiunitary Γ. (auth)

7527 CONTINUOUS DEGENERATE REPRESENTATIONS OF NONCOMPACT ROTATION GROUPS. II. Limic, N.; Niederle, J.; Raczka, R. (International Centre for Theoretical Physics, Trieste, Italy). J. Math. Phys. (N. Y.), 7: 2026-35(Nov. 1966).

Three principal continuous series of most degenerate unitary irreducible representations of an arbitrary noncompact rotation group SO(p,q) have been derived and their properties discussed in detail. The corresponding harmonic functions were constructed. (auth)

7528 SOME OBSERVATIONS ON ENVELOPING ALGEBRAS OF NONCOMPACT GROUPS. Rosen, Joe; Roman, Paul (Boston Univ.). J. Math. Phys. (N. Y.), 7: 2072-8(Nov. 1966).

In order to provide the particle physicist with useful mathematical tools (and a large number of interesting identities), the enveloping algebras of the noncompact homogeneous O(p,q), U(p,q), and inhomogeneous IO(p,q), IU(p,q) groups are discussed in some detail. The construction of the generators of O(p,q + 1) and O(p + 1,q) from the enveloping algebra of IO(p,q) and the analog result for the corresponding pseudo-unitary groups are also presented. (auth)

7529 INFINITE DIMENSIONAL SOLUTIONS OF THE GENERALIZED FEYNMAN–GELL-MANN EQUATION. Mozrzymas, J.; Steslicki, J. (Univ. of Wroclaw). Acta Phys. Pol., 30: 827-31(Nov. 1966).

Some obstacles connected with the problem of the geometrical binding of the Poincaré group and the internal symmetry group SL(2,C) are discussed. The infinite dimensional nonunitary solutions of the generalized Feynman–Gell-Mann equation are obtained in the spinor space. (auth)

7530 DISCRETE DEGENERATE REPRESENTATIONS OF NON-COMPACT UNITARY GROUPS. Raczka, R.; Fischer, J. (International Center for Theoretical Physics, Trieste, Italy). Commun. Math. Phys., 3: 233-57(1966).

Two degenerate principal series of irreducible unitary representations of an arbitrary noncompact unitary group U(p,q) are derived. These series are determined by the eigenvalues of the first and second-order invariant operators, which are shown to possess a discrete spectrum. The explicit form of the corresponding harmonic functions is derived and the properties of the discrete representations are discussed in detail. Moreover, the properties of the corresponding degenerate representations of an arbitrary compact U(p) group are derived. (auth)

Applications (Electromagnetic and Weak)

7531 (CERN-66-29(Vol.1)) PROCEEDINGS OF THE 1966 CERN SCHOOL OF PHYSICS, NOORDWIJK-AAN-ZEE, JUNE 6–18, 1966. (European Organization for Nuclear Research, Geneva (Switzerland)). Oct. 4, 1966. 45p. Dep. mn.

The lectures of the 1966 CERN School of Physics, Noordwijk-aan-Zee, Netherlands, on weak interactions and current algebras are presented. Topics discussed are symmetry, algebra, quark fields and U(3) symmetry, semileptonic weak interactions, U(6) symmetry, saturation and leakage, pole dominated divergence of axial current (PDDAC), the Adler–Weisberger sum rule, strangeness-changing currents, the current-current interaction, nonleptonic hyperon decays, leptonic decays of kaons, and nonleptonic kaon decay. (B.G.D.)

7532 (NYO-1932-114) TEST OF TIME-REVERSAL INVARIANCE IN ELECTROMAGNETIC INTERACTIONS USING THE MOESSBAUER EFFECT. Morita, M. (Columbia Univ., New York). [1966]. Contract AT(30-1)-1932. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Possible time reversal experiments for electromagnetic interactions using the Moessbauer effect and parity experiments in nuclear states are discussed. The idea is the following. With observing electromagnetic subtransitions in nuclear gamma decays where the magnetic quantum numbers of the initial and final states are known with the Moessbauer absorption lines, and ensemble of oriented nuclei are dealt with the emitter so that this kind of nuclear orientation is useful for P and T experiments in beta decays. (B.G.D.)

7533 THE SU_3 ALGEBRA OF CURRENT COMPONENTS AND THE ELECTRIC POLARIZABILITY OF THE NUCLEON. Ragusa, S. (Univ. of Chicago). Nuovo Cimento (10), 46A: 514-18(Dec. 1, 1966). (COO-264-322; EFINS-66-41).

The SU_3 algebra of vector current components and the dipole moment commutation relation are investigated. In particular the SU_6 prediction for the magnetic moments and values for the electric polarizabilities of the nucleon which agree with experiment are obtained. (auth)

7534 LOW-ENERGY THEOREMS AND INTERNAL SYMMETRY. Pais, A. (Rockefeller Univ., New York). Phys. Rev. Lett., 18: 17-19(Jan. 2, 1967).

It is pointed out that the simultaneous use of low-energy theorems and internal symmetries leads to dynamical constraints without any approximation in regard to strong-interaction intermediate states. It is shown first for isospin, then for SU(3), that the simultaneous implementation of each concept leads to consistency conditions of a new kind which does not follow from each alone. When combined with nonsubtracted dispersion relations, the conditions take the form of integral relations between cross sections. They cannot, in general, be satisfied pointwise by cross sections at a given energy. It is shown that they may interconnect with each other distinct multiplets of the internal symmetry. (B.G.D.)

Application (Strong)

7535 (AD-636763) S WAVE PSEUDOSCALAR MESON BARYON SCATTERING IN A SIMPLE MODEL WITH BROKEN SU(3) SYMMETRY. Wyld, H. W. Jr. (Illinois Univ., Urbana, Dept. of Physics). 1965. Contracts Nonr-1834(05); NSF-GP-5622. 47p. CFSTI $3.00 cy, $0.65 mn.

A model of S-wave pseudoscalar meson-baryon scattering is studied in which the force is due to vector meson exchange. The potential is approximated by a static Yukawa potential and the kinematics is simplified. The actual physical masses of the particles are used so that SU(3) symmetry is broken. The resulting problem reduces to a set of coupled channel Schroedinger equations which are solved exactly on a computer. The K matrix and the eigenphases are calculated. Several examples of virtual bound state resonances are found. The model yields a Y_0^* (1405) as a virtual bound state of $\bar{K}N$ and N^* (1510) as a virtual bound state of $K\Sigma$. (auth)

7536 (JINR-E2-3071) SU(3): BREAKING AS CONSEQUENCE OF INTERACTION OF HADRON CURRENTS. Montvai, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 8p. Dep. mn.

Supposing the medium-strong interaction Hamiltonian to be bilinear expression of vector and axial-vector currents, sum rules concerning strong decays and mass splitting are investigated. The derivation of sum rules is based on divergence conditions. (auth)

7537 (JINR-P2-2967) ROZHDENIE VEKTORNOGO MEZONA I SIMMETRIYA $[SU(3) \otimes SU(3)]_{coll}$. (Vector Meson Production and the $[SU(3) \otimes SU(3)]_{coll}$ Symmetry). Winternitz, P.; Zubarev, A. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 9p. (In Russian). Dep. mn.

The collinear production of a vector meson is considered in the scattering of pseudoscalar mesons on baryons. Relations between the experimental quantities, following from the symmetry $[SU(3) \otimes SU(3)]_{coll}$ are obtained. (auth)

7538 BREAKDOWN OF SU_3 SYMMETRY AND BARYON–LEPTON CORRESPONDENCE. Sogami, Ikuo (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 36: 773-80(Oct. 1966).

The mechanism of breakdown of the SU_3 symmetry of hadrons is investigated in unified way by using the composite particle model and the hypothesis of modified baryon-lepton symmetry. The moderately strong mass splitting mechanism is regarded as a result of the μ-e mass difference and the Cabbibo angle is introduced through the formation of electron-muon particle mixtures in the course of the baryon-lepton correspondence. The assumptions yield a mass formula which can explain the tendency of the mass splittings among the components of the same isomultiplet as well as the Gell-Mann-Okubo mass relations. From the analysis of these isomultiplet mass splittings a rough estimate is found for the value of the Cabbibo angle; $0.17 \geq \sin\theta \geq 0.14$. In addition a comparison of two types of composite model, namely quark model and the quartet model, is given. (auth)

7539 HYPERCHARGE CONSERVATION AND THE SHMUSHKEVICH PRINCIPLE. Takagi, Fujio (Tohoku Univ., Sendai). Progr. Theoret. Phys. (Kyoto), 36: 849-51(Oct. 1966).

It is argued that the 39 hypercharge-nonconserving Yukawa-type couplings between the baryons (N, Λ, Σ, Ξ, Δ, Ω) and mesons (π, κ, η) are all forbidden by the Shmushkevich principle (SP) and charge conservation. By introducing an imaginary charged singlet meson, a counter example is constructed which does not conserve the hypercharge but satisfies both SP and CC. It is concluded that hypercharge conservation cannot be derived from SP and CC only in general. (L.B.S.)

7540 CONNECTION BETWEEN EXTERNAL AND INTERNAL SYMMETRIES OF STRONGLY INTERACTING PARTICLES. Flato, Moshe; Sternheimer, Daniel (Institut Henri Poincare, Paris). J. Math. Phys. (N. Y.), 7: 1932-58(Nov. 1966).

The relation between the mass and spin-parity J^P, and internal quantum numbers of elementary particles, hints at a nontrivial connection between the external symmetry, namely the Poincaré group or its Lie algebra, and a so-called internal symmetry. Studying this connection mathematically, it is found that any extension of (resp. by) the Poincaré Lie algebra $\mathscr{P}$ by (resp. of) a semisimple Lie algebra $\mathscr{S}$ is equivalent to the trivial one, $\mathscr{P} \oplus \mathscr{S}$. Moreover, if we are looking for a Lie algebra containing $\mathscr{P}$ and $\mathscr{S}$ in an economical and nontrivial way, namely what we call a (nontrivial) unification of $\mathscr{P}$ and $\mathscr{S}$, restrictions are found on the possibilities of choice of $\mathscr{S}$, which exclude compact internal symmetries. An explicit treatment of SL(3,c) as internal symmetry, related to the external symmetry by the unification process of Lie algebras, gives a mass formula which is in very good accordance with the experimental data, and can be theoretically interpreted by means of a so-called "classification principle". (auth)

7541 CALCULATION OF QUANTUM NUMBERS OF SOME REPRESENTATIONS OF THE SU_6 GROUP. Stavraki, G. L. (Inst.

of Physics and Tech., Kiev). Ukr. Fiz. Zh., 11: 1198-1205(Nov. 1966). (In Ukrainian).

A method for calculating the quantum numbers of representations with undegenerated weights of the SU_6 spin-unitary group by means of root and weight formalism is considered. An explicit linear transformation is found, connecting the "physical" basis and the Lee algebra Weil basis of the SU_6 group. The method is illustrated by an example of the calculation of the magnetic moments of the baryon 56-plet. (auth)

7542 MESON–BARYON FORWARD SCATTERING IN RELATIVISTIC THEORY OF SPIN AND UNITARY SYMMETRY. Bokov, O. G.; Nguyen Van Hieu; Sredniawa, B. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 30: 753-66(Nov. 1966).

In the scheme of SU(6) symmetry all possible relations among meson–baryon forward scattering amplitudes are systematically studied. In the frame of U(6,6) the most general expression including 30 regular and irregular amplitudes is obtained for the forward meson–baryon scattering matrix element, the last being invariant under $SU(6)_W$. The method applied differs from that developed in J. C. Carter, et al., Phys. Rev. Letters, 15, 373, 1965. It is shown that many relations which were obtained for forward meson–baryon scattering cross sections are not the consequences of $SU(6)_W$ as they hold only in the nonrelativistic limit, provided only regular amplitudes are taken into account. (auth)

7543 $SU_3 \otimes SU_3$ SYMMETRY AND THE POSSIBLE EXISTENCE OF A BOSON 27-PLET. Bose, S. K. (IAEA, Trieste, Italy). Nuovo Cimento (10), 46A: 419-22(Nov. 21, 1966). (COO-427-58).

It is shown that each of the meson multiplets can be put in the representation $(3,3^*)$ of the SW_3 group of the nonchiral $SU_3 \otimes SU_3$. Generalized forms of the usual nonet mass relations are derived in the $(6,6^*)$-plet representation and the 1^- and 2^+ mesons are discussed in terms of this representation. (G.O.Y.)

7544 SUM RULES FOR BARYON RESONANCE WIDTHS. Sakita, Bunji (Univ. of Wisconsin, Madison); Wali, Kameshwar C. Phys. Rev. Lett., 18: 29-31(Jan. 2, 1967).

Meson–baryon scattering is considered within the framework of SU(3) symmetry and the relations between masses and widths of baryonic resonances with different total angular momentum are discussed. (B.G.D.)

Quantum Field Theories

Refer also to abstracts 7385, 7394, 7395, and 7478.

7545 (DESY-66/26) CONSTRUCTION OF A GAUGE-INVARIANT CUTOFF OF QUANTUM ELECTRODYNAMICS FROM A NON-LOCAL GAUGE-INVARIANT LAGRANGIAN. Fraas, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sept. 1966. 28p. Dep. mn.

A nonlocal gauge-invariant Lagrangian is given, which describes gauge-invariant quantum electrodynamics with a modified fermion propagator. Some examples are discussed. (auth)

7546 (JINR-E2-3003) NOTE ON THE PARASTATISTICS. Govorkov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 6p. Dep. mn.

It is shown in terms of the Wightman functions for the Green ansatz components that parafields are canonical (Fermi- or Bose-) fields with a certain degree of freedom but written in another form. The hypothesis of paraquarks and its relation to the assumption about the existence of three quark triplets are discussed. (auth)

7547 (JINR-P2-3010) K TEORII 2(2s + 1)-KOMPONENTNYKH SVOBODNYKH KVANTOVANNYKH SPINORNYKH POLEI. I. (To the Theory of 2(2s + 1)-Component Free Quantized Spinor Fields. I). Khodzhaev, L. Sh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 18p. (In Russian). Dep. mn.

The 2(2S + 1)-component free spinor fields are formulated using the group theory and the theory of functionals. This approach may be used for a further investigation of covariant structure of causal S-matrix elements. (auth)

7548 PROPAGATOR AND VERTEX FUNCTION OF A BOUND STATE IN THE GREEN'S FUNCTION FORMALISM. Nakanishi, Noboru (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 36: 799-819(Oct. 1966).

On the basis of the scattering Green's function formalism, definitions of the propagator and the vertex function corresponding to a bound state are proposed in such a way that they coincide with the conventional definitions if the state considered happens to be an elementary particle. They are required to satisfy certain integral equations and three additional requirements. The appropriateness of these conditions is discussed in a chain model and in a modified chain model. The Zachariasen model is also discussed in connection with the renormalization problem. It is demonstrated how to find the propagators and the vertex functions of bound states in the Wick-Cutkosky model and in the ladder model for non-zero exchanged-meson mass, and they are explicitly found in some special cases of the former model. The definition of the bound-state field operator due to Nishijima, Zimmermann and Haag is discussed in the Green's function formalism and compared with the above definition of the bound-state propagator. (auth)

7549 MANIFESTLY COVARIANT DESCRIPTION OF ARBITRARY DYNAMICAL VARIABLES IN RELATIVISTIC QUANTUM MECHANICS. Fleming, Gordon N. (Pennsylvania State Univ., University Park). J. Math. Phys. (N. Y.), 7: 1959-81(Nov. 1966).

The concepts of instantaneous observables and dynamical variables are analyzed and generalized to arbitrary spacelike hyperplanes. A formalism is developed which gives the basic equations of relativistic quantum mechanics for dynamical variables on arbitrary hyperplanes a manifestly covariant form. A covariant linear transformation on the Poincaré generators introduces the hyperplane generators which yield commutation relations displaying a clear separation of the kinematical and dynamical properties of dynamical variables. An axiomatic study of the center-of-mass position operator yields the uniqueness of the operator and completes the physical interpretation of the hyperplane generators. The Poincaré invariance and hyperplane independence of the scattering operator is related to asymptotic conservation laws in the hyperplane formalism, and finally, a nonlocal, hyperplane-dependent, field theory of free spinless particles is considered. (auth)

7550 EXISTENCE OF PARTICLE-LIKE SOLUTIONS TO NONLINEAR FIELD THEORIES. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). J. Math. Phys. (N. Y.), 7: 2066-70(Nov. 1966).

A pseudovirial theorem is derived for time-independent particle-like solutions of finite energy (singularity-free and spatially localized time-independent solutions) to field theories associated with an action principle. It is shown that a useful necessary condition for the existence of such particle-like solutions is generally obtainable as a corollary to the pseudovirial theorem. This necessary condition is in fact sufficient to preclude existence of any well-localized particle-like solution for all but special field theories with the more common forms of algebraic interaction. On the other hand, strong satisfaction of the necessary condition can lead to model field theories with rigorous closed-form particle-like solutions, as shown by example for a class of Lorentz-covariant theories which feature a real scalar field in interaction with a two-component complex Weyl spinor field. Some of the latter particle-like solutions to the scalar–spinor theory are energetically stable with respect to spatial dilatations, hence likely to be stable in the dynamical sense. A counter example to the more general sufficiency of the strong satisfaction condition is presented, showing that strong satisfaction of the pseudovirial theorem's corollary does not always guarantee the existence of singularity-free particle-like solutions. (auth)

7551 A NON-HILBERT-SPACE FORMULATION OF QUANTUM FIELD THEORY. Prugovecki, Eduard (Univ. of Alberta, Edmonton). J. Math. Phys. (N. Y.), 7: 2107-?(Nov. 1966).

Based on earlier papers in which a non-Hilbert-space formalism for quantum physics, called the $\mathcal{U}$-formalism, was proposed, a new formalism for quantum field theory is developed by introducing the field concept into the $\mathcal{U}$-formalism. The present formalism is then compared with the Wightman approach and with the Haag–Araki approach to quantum field theory. The necessity of a global vacuum within the $\mathcal{U}$-framework and the alternative concept of the local vacuum are discussed. (auth)

7552 NONEXISTENCE OF LOCALIZED PERIODIC SOLUTIONS TO NONLINEAR FIELD THEORIES. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). J. Math. Phys. (N. Y.), 7: 2071(Nov. 1966).

A simple proof is given which precludes the existence of any spatially localized and temporally periodic singularity-free solution to the c-number field equation for a physically interesting Lorentz-covariant self-interacting scalar theory. (auth)

7553 ENERGY-MOMENTUM TENSOR OF SPIN ½ PARTICLES. Piasecki, J. (Univ. of Warsaw). Acta Phys. Pol., 30: 791-9(Nov. 1966).

The structure of the matrix elements of the symmetrical energy-momentum tensor between one-particle spin ½ states is discussed. For definiteness the case of the one-electron system is examined.

Two different methods were applied to the problem of computing the matrix elements to the lowest order in the fine-structure constant $\alpha = (e^2/4\pi)$. (a) Using the perturbation approach the matrix elements are related to the corresponding transition amplitudes in an external gravitational field. The actual form of the mechanical form factors of the system is established. (b) The imaginary part of the form factors is calculated by relating the matrix elements to the negaton–positon scattering processes. There is a complete agreement between the two methods. (auth)

7554 NONLINEAR THEORY WITH HERMITEAN SPINOR FIELD OPERATORS. Duerr, H. P.; Wagner, F. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cimento (10), 46A: 223-80(Nov. 21, 1966).

The nonlinear spinor theory is formulated in terms of Hermitean spinor field operators. The functional equations for the generators of matrix elements for the time-ordered and normal-ordered products for these operators, and the explicit form of the resulting systems of coupled differential and integral equations for the matrix elements are derived. A graphical description of these equations is given, which proves very useful for practical computations. Masses and coupling constants approximately derived in earlier papers are recalculated, and equations for the fermion and boson propagators are given. (auth)

7555 CURRENT COMMUTATION RELATIONS IN THE FRAMEWORK OF GENERAL QUANTUM FIELD THEORY. Schroer, B. (Univ., Hamburg); Stichel, P. Commun. Math. Phys., 3: 258-81(1966).

A rigorous formulation of Gell-Mann's equal time commutation relations in the framework of general quantum field theory is given. It is shown that this can be achieved despite the nonexistence of charge operators for nonconserved currents. Starting from the properly formulated equal time commutation relations of "generalized charges," the application of the Gauss-Theorem is justified, and the limits for large times of time dependent "generalized charges" are discussed. The Jost-Lehmann-Dyson representation is used in order to show that the equal time commutation relations always lead to exactly one, frame independent, sum rule. The connection between properties of the Jost-Lehmann-Dyson spectral function and the convergence of Adler-Weisberger type sum rules are discussed. (auth)

7556 SPECTRAL CONCEPTS IN COORDINATE SPACE. Shabad, A. E. Tr. Fiz. Inst., Akad. Nauk SSSR, 29: 151-4(1965). (In Russian).

An attempt was made to show that the general properties of relativistic causality invariance and a complete system of conditions with positive energies (spectrality) enable one to express the vacuum mean of products of two Heisenberg operators of a Bose field φ as various space–time points x and y $\langle 0|\varphi(x)\varphi(y)|0\rangle$ and vacuum of their chronological product $\langle 0|T(\varphi(x)\varphi(y))|0\rangle$ as integrals for $(x-y)^2$, according to the form identical to the Källen–Lehmann concept in momentum space for the Fourier-transform of vacuum means correspondingly advancing (delaying) commutator and antichronological product. (R.V.J.)

7557 SINGULAR BEHAVIOR OF OPERATOR PRODUCTS FOR THE gphi^3 INTERACTION. Estberg, Gerald Norman. Ithaca, N. Y., Cornell Univ., 1966. 65p.

Thesis.

The singular behavior of operator products at small separations is investigated for the specific model of the $g\phi^3$ interaction of a neutral scalar field. It is found that this behavior is consistent with the hypotheses proposed by Wilson about the behavior of operators in quantum field theory provided that the hypotheses are modified to take into account the dimensionality of the coupling constant in the $g\phi^3$ interaction. The singular behavior of that part of the expression for the operator product containing the coupling constant is reduced from that which would be expected from an interaction with a dimensionless coupling constant. As a consequence it follows that the interacting scalar field must obey the free field canonical commutation rules. The singular behavior is investigated by examining the behavior of the connected parts of the time ordered products of field operators (Green's functions) at large momenta. An infinite set of equations are derived for these quantities. Their behavior is examined by two approximation methods: an expansion through fourth order in perturbation theory, and by truncating the equations so that only a finite number of equations are considered. Specifically the equation for the self energy with a constant vertex function and the coupled equations for the self energy and a non-constant vertex function are investigated (all other connected Green's functions being set equal to zero). The existence of a solution to the equations is proven in the Euclidean metric for small enough values of the coupling constant and an expansion for the behavior of the solution at large momenta is obtained. The behavior for both approximation methods is found to be consistent with the modified hypotheses. (Diss. Abstr.)

7558 EQUIVALENCE OF ALTERNATIVE FORMULATIONS OF SCATTERING IN MODEL FIELD THEORIES. Gelman, Harry. New York, New York Univ., 1964. 194p.

Thesis.

The scattering problem for a class of static source quantum field theories is discussed from the viewpoint of several different scattering formalisms. These are the Gell–Mann–Goldberger formalism, in which eigenstates of a free particle Hamiltonian represent the asymptotic states, the formalism of Ekstein, in which the asymptotic states are represented by vectors describing noninteracting physical particles, and the formalism based on the axiomatic description of field theory of Lehmann, Symanzik, and Zimmermann. For the class of field theories treated, all of these formalisms are shown to give equivalent formulations of the scattering problem in the sense that for all of them, the scattering eigenstates are identical, and the energy shell values of the transition matrix in each formalism are identical for any given collision process. (Diss. Abstr.)

7559 PROCEEDINGS OF A CONFERENCE ON THE THEORY AND APPLICATIONS OF ANALYSIS IN FUNCTION SPACE HELD IN DEDHAM, MASSACHUSETTS, JUNE 9–13, 1963. Martin, William Ted; Segal, Irving (eds.). Cambridge, Mass., Massachusetts Institute of Technology Press, 1964. 224p. $6.00. (CONF-630604-).

A mathematical clarification of functional integration and its application to physical problems is presented. The topics covered include random theory in phase space and quantum mechanics, function space integrals, a method of solution for quantum field theory, classical analysis on a Hilbert space, tempered distributions in functional space, Schroedinger particles interacting with a quantized scalar field, developments in renormalization theory, and quantum fields and analysis in the solution manifolds of differential equations. Also included are applications of function space integrals to problems in equilibrium statistical mechanics and to nonrelativistic physical problems, C* algebra approach to field theory, the mathematical structure of quantum field theory, and the application of functional integrals to Euclidean quantum field theory. (J.F.P.)

Scattering Theory

Refer also to abstract 7558.

7560 (AD–633837) TIME-SMOOTHED ASPECTS OF RATE AND CROSS-SECTION MEASUREMENTS. Golden, Sidney; Felton, Ronald H. (Brandeis Univ., Waltham, Mass. Dept. of Chemistry). May 15, 1966. Contract Nonr-1677(01). 28p. (TR–17). CFSTI $3.00 cy, $0.65 mn.

The measurement aspects of experiments designed to yield information about rates at which certain processes occur in a system, as well as their relevant cross-sections, are discussed. As a closer approximation to experimental quantities, their time-smoothed theoretical counterparts are dealt with. The asymptotic behavior of these quantities, as the interval of time-smoothing becomes indefinitely large, is examined. In the long-term time averaged sense, it is shown that cross-sections computed from transition probabilities or rates of change of transition probability yield equivalent results in the limit of the system approaching a zero value of its density. The equivalence of the cross-section based upon a stationary state formalism is also established. The formal equivalence holds for many-particle systems. (auth)

7561 (JINR–P2-3018) OPTICHESKAYA MODEL UPRUGOGO RASSEYANIYA NA UGOL 180 DEG PRI VYSOKIKH ENERGIYAKH. (Optical Model of High Energy Elastic Scattering at 180 Deg). Stavinskii, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 5p. (In Russian). Dep. mn.

An analysis is made of the experimental data on high energy elastic scattering of particles at large angles from the optical point of view. The parameters of the interaction are obtained. (auth)

7562 (JINR–P2-3045) KOVARIANTNAYA STRUKTURA ELEMENTOV PRICHINNOI S-MATRITSY DLYA PROIZVOL'NOGO SPINA. II. (Covariant Structure of Causal S-Matrix Elements for an Arbitrary Spin. II). Khodzhaev, L. Sh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 10p. (In Russian). Dep. mn.

In the framework of the Bogoliubov's asymptotic causal S-matrix theory a covariant tensor generalized M-functional is determined which transforms by tensor product of nonunitary finite noncompact representations of the universal i SL (2,C) group of the $P_+^\uparrow$ Poincaré group. (auth)

7563 (JINR-P4-2983) STOLKNOVENIYA S PERERASPREDELENIEM CHASTITS. (Collisions With Particle Redistribution). Amirkhanov, I.; Zhigunov, V. P.; Zakhar'ev, B. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 18p. (In Russian). Dep. mn.

A system of coupled differential equations, describing the scattering processes with particle redistribution is deduced and investigated. A method of solving such a system is suggested. A set of integral equations is obtained for the scattering amplitudes with particle redistribution. (auth)

7564 (MIT-2098-197) IRREGULAR POTENTIALS FROM THE GELFAND-LEVITAN EQUATION. Coz, Marcel (Massachusetts Inst. of Tech., Cambridge). Oct. 21, 1965. Contract AT(30-1)-2098. 42p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

There is a complete equivalence between the uniqueness of the solution of the Gelfand-Levitan equation and the existence of a unique local nonmomentum-dependent potential for an l-wave scattering. This allows in some instances a determination of a unique potential which has no property of regularity. In particular one can obtain potentials which have bound states in the continuum and even potentials with discrete but nonnormalisable solutions, however the last case corresponds to a potential whose set of solutions is not complete. (auth)

7565 IMPACT PARAMETER FORMALISM. IV. THE NON-ZERO SPIN CASE. Adachi, Toshimi (Tokyo Metropolitan Technical Coll.); Kotani, Tsuneyuki; Takeda, Minoru. Progr. Theoret. Phys. (Kyoto), 36: 745-60(Oct. 1966).

An extension of our impact parameter formalism to the elastic scattering of particles with spin is proposed; this is valid for arbitrary physical energies and scattering angles. The helicity representation of the full scattering amplitude and the Jacob-Wick partial wave expansion are used. The impact parameter amplitude is related to both the full scattering and the partial wave amplitudes without introducing any approximation. (auth)

7566 DISPERSION THEORY AND IMPULSE APPROXIMATION FOR BOUND-STATE PROBLEMS. Biebl, K.-J.; Kaschluhn, F. (Humboldt-Univ., Berlin. Forschungsstelle fuer Physik hoher Energien, Berlin). Fortschr. Phys., 14: 317-55(1966).

Bound state problems are discussed within the framework of dispersion theory using the impulse approximation in its relativistic form for the treatment of scattering processes. A general outline of the impulse approximation is given, which is based on the assumption that the projectile particle acts only on one of the constituents of the bound state, respectively, whereas the others remain as spectators. After treating the nonrelativistic case within potential theory the relativistic generalization is discussed. A study is made of the analytic properties of the deuteron-nucleon form factor with one nucleon off the mass shell, considering only the spinless case. First, the anomalous singularities within the two-particle approximation of the unitarity relation for the form factor are investigated. Next, the anomalous branch cuts connected with contributions from many-particle states to the unitarity relation of the form factor are investigated. A detailed comparison is made of the analytic properties of the deuteron-two-nucleon form factor with those of the Fourier transform of the deuteron bound-state wave function obtained from potential theory in the nonrelativistic, instantaneous limit. (L.B.S.)

7567 CURRENT ALGEBRA AND NON-REGGE BEHAVIOR OF WEAK AMPLITUDES. Bronzan, J. B. (Massachusetts Inst. of Tech., Cambridge); Gerstein, I. S.; Lee, B. W.; Low, F. E. Phys. Rev. Lett., 18: 32-5(Jan. 2, 1967).

The covariant scattering amplitude $T_{\mu\lambda}(s,t,q_1^2,q_2^2)$ for the process $\gamma_{q1} + \pi_{p1} \rightarrow \gamma_{q2,\mu} + \pi_{p2}$, where $\gamma_{q1,\mu}$ represents an isovector photon of four-momentum $q_{1\lambda}$ and polarization index μ, and π_{p1} represents a pion of four-momentum $p_{1\lambda}$, is considered. The variables s and t are given by $s = (p_1 + q_1)^2$ and $t = (p_1 - p_2)$. (B.G.D.)

7568 DEFINITION AND EXISTENCE OF MULTICHANNEL SCATTERING STATES. Sandhas, Werner (Freie Univ., Berlin). Commun. Math. Phys., 3: 358-74(1966).

The field theoretical formulation of quantum mechanics is used to consider the nonrelativistic multichannel scattering theory. With the help of appropriately constructed time dependent creation operators, Hilbert vectors are formed whose limits in time can be defined as multichannel scattering states in the usual sense. The existence of these states is proved under certain assumptions for the potential, by showing the convergence of the above mentioned operators. The commutation relations for the limits of these operators are given. (auth)

7569 VALIDITY OF PERTURBATION SERIES WITH ZERO RADIUS OF CONVERGENCE. Baker, George A. Jr. (Brookhaven National Lab., Upton, N. Y.); Chisholm, Roy. J. Math. Phys. (N. Y.), 7: 1900-2(Nov. 1966). (BNL-10053).

Although the perturbation expansion for the S matrix of the Peres-model field theory has zero radius of convergence, it uniquely defines the S matrix and is easily summable by the method of Padé approximants. (auth)

7570 BI-ORTHOGONALITY RELATIONS FOR SOLVING HALF-SPACE TRANSPORT PROBLEMS. McCormick, N. J.; Kuscer, I. (Univ. of Ljubljana, Yugoslavia). J. Math. Phys. (N. Y.), 7: 2036-45(Nov. 1966).

The method of singular eigenfunction expansions is applied to time-independent, one-speed, half-space transport problems with anisotropic scattering. Adjoint eigenfunctions are constructed such that a set of half-range bi-orthogonality relations is valid. These relations lead to the expansion coefficients in a direct manner. The adjoint eigenfunctions are also used to express the half-space albedo operator which relates the emerging angular density to the ingoing one. (auth)

7571 ANALYTIC PROPERTIES OF A CLASS OF POTENTIALS AND THE CORRESPONDING JOST FUNCTIONS. Sabatier, Pierre C. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). J. Math. Phys. (N. Y.), 7: 2079-91 (Nov. 1966).

Analytical properties of the potential obtained by Newton's method in the inverse scattering problem at fixed energy are thoroughly investigated. It is found that r V(r) is analytic in the neighborhood of r = 0 and can be continued in the r complex plane as a meromorphic function, the poles of which are of order at least equal to 2. An explicit formula is given to yield the Jost functions for any complex value of the angular momentum v. They appear to be meromorphic functions with poles located at the negative integers on the real axis. The zeros of $f_2(v)$, for large $|v|$ and for Re v and Im v > 0, are located on a curve which is the boundary of a domain previously shown to contain no Regge pole. The interpolated scattering amplitude is unitary. It behaves for $v \rightarrow -i\infty$ as $e^{\tau|\tau|}$. An important result is that the class of potentials obtained by Newton's method is much more restricted than one might think. This led to a search for a more general approach to the inverse scattering problem, which is the subject of a forthcoming publication. In order to illustrate the method, a detailed study of an example previously introduced by R. G. Newton is given. In the last Appendix, a very remarkable property of the potentials involved in this example is given: the scattering amplitude corresponding to these potentials can be given an exact closed form. Since the corresponding potentials are strongly energy-dependent, it is very likely that this is only a mathematical curiosity. (auth)

7572 RADIATIVE TRANSFER. II. Siewert, C. E.; Zweifel, P. F. (Middle East Technical Univ., Ankara). J. Math. Phys. (N. Y.), 7: 2092-2102(Nov. 1966).

An exact solution to the equations of radiative transfer for a generalization of the Uniform-Picket-Fence model discussed in a previous work is presented. Here the absorption coefficient is allowed to take N different values over the frequency spectrum. Case's method is used to construct the normal mode solutions to the set of N coupled integral equations. Then half-range completeness and orthogonality theorems are proved that enable one to solve typical half-space problems. Explicitly, the asymptotic solution to the Milne problem is developed, including the extrapolated end point, while implicitly the complete solution is available. (auth)

7573 THEOREM ON PERATIZATION OF SINGULAR POTENTIALS AND OTHER MISCELLANEA. Spector, Richard M. (Wayne State Univ., Detroit). J. Math. Phys. (N. Y.), 7: 2103-6(Nov. 1966).

It is proved for potentials of the form $V(r) = A(r)/r^n (n > 3)$ [with A(r) more singular at r = 0 than r(dA/dr), or approaching zero less rapidly] that the peratized scattering length can be written down immediately in known form. The distinction between regularization and peratization is made clear, and a common conjecture about the g (coupling constant) behavior of the peratized scattering length is disproved by a counter example. Finally, various mistakes in the literature are corrected. (auth)

7574 SYMMETRY, UNIVERSALITY, AND NONVANISHING ASYMPTOTIC TOTAL CROSS-SECTIONS. Freund, P. G. O. (Univ. of Chicago). Nuovo Cimento (10), 46A: 563-6(Dec. 1, 1966).

It is argued that the concepts of symmetry and universality are completely compatible with nonvanishing asymptotic cross sections. Experimental evidence is presented that strongly supports this conclusion. (L.B.S.)

7575 INTRODUCTION TO REGGE POLES. Kummer, Wolfgang (Technische Hochschule, Vienna). Fortschr. Phys., 14: 429-81(1966).

A self-contained approach to Regge poles is given for low and high energy potential scattering. The high-energy behavior of scattering amplitudes is also discussed. (J.F.P.)

7576 THE BORN SERIES FOR NONLOCAL POTENTIALS (S-WAVE). Bertero, M. (Univ., Bonn); Talenti, G.; Viano, G. A. Nuovo Cimento (10), 46A: 337-63(Nov. 21, 1966).

A sufficient condition for the convergence of the Born series for nonlocal potentials is derived. The analysis is restricted to the S-wave Schrödinger equation. In order to have some information on on the general structure of the scattering solution as a function of the potential strength g and of the linear momentum k, the separable potentials are reconsidered. (auth)

7577 IMPACT-PARAMETER DESCRIPTION OF RELATIVISTIC SCATTERING. Henzi, R. (CERN, Geneva). Nuovo Cimento (10), 46A: 370-406(Nov. 21, 1966).

An impact-parameter description of the scattering of relativistic particles is established which, at high energy, is completely analogous to the picture of high-energy scattering in Schrödinger's theory. The investigation is based entirely on general properties like analyticity and unitarity of the relativistic scattering amplitude. (auth)

7578 CHANGE OF PARITY IN INELASTIC SCATTERING. Shebeko, O. V. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 11: 1206-7(Nov. 1966). (In Ukrainian).

The change of parity in inelastic scattering is discussed and a new derivation of Glendenning's rule is proposed. (G.O.Y.)

7579 THEORY OF A NONLOCAL SEPARABLE POTENTIAL. Rokhlenko, O. V. Ukr. Fiz. Zh., 11: 1208-14(Nov. 1966). (In Ukrainian).

The theory of nonlocal separable potential is extended to the case of complex l and k. An analytical continuation is constructed for the partial harmonics of the scattering matrix. Equations are obtained of the principal Regge trajectories with large |k|. The sufficient conditions are deduced for the existence of complete scattering amplitude in a physical region. (auth)

7580 ON THE THRESHOLD BEHAVIOR OF PARTIAL-WAVE AMPLITUDE IN THE FROISSART N/D-METHOD. Chermalikh, G. M. (Inst. of Physics and Tech., Kiev). Ukr. Fiz. Zh., 11: 1172-5(Nov. 1966). (In Ukrainian).

It is shown that the introduction of the threshold factor into the inelasticity function in the Froissart N/D method, proposed by Islam and Kang for deriving the partial-wave amplitude with the correct threshold behavior, leads to an exponential increase of the D-function. (auth)

7581 METHOD FOR SOLVING THE INVERSE PROBLEM IN POTENTIAL SCATTERING. Blazek, M. (Czechoslovak Academy of Sciences, Bratislava). Commun. Math. Phys., 3: 282-91(1966).

A method for solving the inverse problem in the nonrelativistic elastic scattering theory, using the analytic and asymptotic properties of the scattering amplitude is proposed and the influence of the discontinuity parameters of the scattering amplitude on the properties of the resulting potentials is discussed. The case with spherically symmetric forces and without bound states is considered. The possibility for solving the inverse problem by this method, leading to the singular repulsive potentials, is mentioned. (auth)

Particle Accelerators

Refer also to abstracts 6122, 6123, 6779, 6780, 6984, 7271, and 7272.

7582 (AECL-2635) SOME NEUTRON MEASUREMENTS WITH SIMULATED ING TARGETS. Walker, J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). June 1966. 53p. Dep. mn. AECL $1.50.

Thermal neutron fluxes in the vicinity of a simulated Intense Neutron Generator target were measured using Mn and Au foils and a small BF_3 detector. The target was a Pb cylinder either 4" or 8" in diameter with a 1.2 g Ra-Be neutron source at its center. This was centrally mounted in a 5' diam. × 5' high tank which was filled with either H_2O or D_2O moderator. Various gaps and absorbing annuli were placed around the target, and air-filled aluminum beam tubes were mounted radially or tangentially from the target to simulate typical ING conditions. The measured thermal neutron fluxes were less than calculated at all radii. The single-age computation clearly gives large errors at large radii, but the multienergy approach seems to give a useful indication of the thermal flux distribution in spite of the extreme simplicity of the model. The fall in measured fluxes at small radii in both D_2O and H_2O is most likely caused by absorption in the target material which is not allowed for in the computational model. (auth)

7583 (AECL-2818) INTENSE NEUTRON GENERATOR. Lewis, W. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1966. 12p. (DL-72). Dep. mn. AECL $0.50.

The economic and research contexts that would be served by producing neutrons in gram quantities at high intensities by electrical means without uranium-235 are discussed. The revenue from producing radioisotopes is attractive. The array of techniques introduced by the multipurpose 65 megawatt Intense Neutron Generator project includes liquid metal cooling, superconducting magnets for beam bending and focusing, superconductors for low-loss high-power radiofrequency systems, efficient devices for producing radiofrequency power, plasma physics developments for producing and accelerating hydrogen ions at high intensity that are still far out from established practice, a multimegawatt high voltage dc generating machine that could have several applications. The research fields served relate principally to materials science through neutron-phonon and other quantum interactions as well as through neutron diffraction. Nuclear physics is served through μ-, π- and K-meson production. Isotope production enters many fields of applied research. (auth)

7584 (BNL-9581) ELECTRONIC RIPPLE FILTER FOR THE AGS MAIN MAGNET POWER SUPPLY. Halama, H. J.; Cassel, R. L. (Brookhaven National Lab., Upton, N. Y.). Oct. 6, 1965. Contract AT(30-2)-Gen-16. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For high energy experiments at Brookhaven Alternating Gradient Synchrotron requiring a long particle spill at constant energy, the ripple of the magnet power supply is several thousands of volts. This voltage ripple produces a ripple in the magnetic field which causes a radial motion in the orbit of accelerated particles. The design and performance of an apparatus which reduces the ripple to less than 5% of the unfiltered value are described. It is a closed loop system with a carefully controlled transfer function. A large power tube used as a shunt regulator is driven from an rf link by low level circuits at ground potential. (auth)

7585 (BNL-10834) EQUIVALENT CIRCUIT AND DISPERSION RELATION FOR THE MULTISTEM DRIFT TUBE STRUCTURE. Nishikawa, T. (Brookhaven National Lab., Upton, N. Y.). Nov. 18, 1966. Contract AT(30-2)-Gen-16. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The coupled dispersion curves for TS and TM modes in terms of an equivalent circuit for the multistem structure are considered. It is pointed out also that the lumped circuit constants determined from the measured frequencies have a reasonable N-dependence for the N = 1, 2, 3, and 4 stem structures. (B.G.D.)

7586 (CEA-R-3002) ETUDE THEORIQUE ET EXPERIMENTALE DE LA FOCALISATION DES IONS AFIN D'AMELIORER LA BRILLANCE DU FAISCEAU IONIQUE PAR SUPPRESSION DES CAUSES D'ABERRATIONS. (Theoretical and Experimental Study of Ions Focusing Systems in Order to Improve the Ions Beam Brightness by Suppressing Aberration Causes). Faure, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 73p. (In French). Dep. mn.

Thesis. Submitted to Univ., Paris.

It is shown that a beam brightness can be improved by an order of magnitude when the sources of aberrations are suppressed in the anode region source, as well as in the extraction region and in the electrostatic focusing system. A calculation was first set up to determine a simple focusing system. The aberration ratio due to this focusing system is smaller than 10 to 15 per cent. The experimental study was developed by using an ion source and its extraction system capable of producing an aberration free beam at an energy of 20 keV and an accelerating unit up to 190 keV that confirms that the qualities of a 35 mA beam produced by the said ion source are not spoiled when the beam goes through the focusing and accelerating system that was designed to be aberration free. (auth)

7587 (JINR-P-9-3017-1) VERTIKAL'NOE DVIZHENIE IONOV V TSENTRAL'NOI OBLASTI RELYATIVISTSKOGO TSIKLOTRONA. (Vertical Motion in the Central Region of a Relativistic Cyclotron). Glazov, A. A.; Kochkina, T. P.; Novikov, D. L.; Onishchenko, L. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 19p. (In Russian). Dep. mn.

A theoretical analysis of the ion vertical motion in the central region of a relativistic cyclotron is given. The calculation of the motion was performed with an electronic computer; an electric field of the accelerating system was determined by electrolytic tank for the real configuration of the central optics. The motion of two configurations of the beam defining system was calculated.

Numerous graphs, characterizing the advantages of the chosen configuration of the central optics, are given. (auth)

7588 (LA-3624) QUARTERLY STATUS REPORT ON THE MEDIUM-ENERGY PHYSICS PROGRAM FOR PERIOD ENDING OCTOBER 31, 1966. (Los Alamos Scientific Lab., N. Mex.). Nov. 1966. Contract W-7405-eng-36. 71p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The medium-energy physics program at LASL which deals with the new Los Alamos Meson Physics Facility is discussed. The topics considered are progress of the 800 MeV proton linac especially in the accelerator structures, rf power sources, control and instrumentation, accelerator physics, and project scheduling and facilities planning. (B.G.D.)

7589 (LA-DC-8260) FAST RF CONTROL WORK AT LASL. Jameson, R. A.; Hoffert, W. J.; Lindsay, N. A. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 3p. (CONF-661021-25). DTIE.

From Linear Accelerator Conference, Los Alamos, N. Mex.

Fast closed loop control of rf phase and amplitude is necessary to maintain stable acceleration in the LAMPF proton linac. The results of a closed loop rf phase control system using a coaxitron power amplifier driving a full-scale accelerator structure are presented, demonstrating correction bandwidths greater than 200 kHz. Overall rf control system design and component development is discussed, and the proposed interplay between the fast rf control system and the central, digital computer based, machine control system is outlined. A review of current work to evaluate the control characteristics of various types of high-power rf amplifiers concludes the discussion. (auth)

7590 (LA-DC-8297) MODULATOR DEVELOPMENT AT LOS ALAMOS SCIENTIFIC LABORATORY. Freyman, Robert W.; Severns, Rudolph P. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 9p. (CONF-661021-26). DTIE.

From Linear Accelerator Conference, Los Alamos, N. Mex.

The requirements, development, and operation of hard tube modulators for the Los Alamos meson facility are discussed. (B.G.D.)

7591 (SAL-5) A STUDY OF A FOCUSSING SYSTEM FOR POSITRON BEAMS. Lobb, Donald Edward (Saskatchewan Accelerator Lab., Univ. of Saskatchewan, Saskatoon). Mar. 1966. 230p. Dep. mn.

Thesis.

A positron accelerator design proposed by Varian Associates (1962) (see also Nunan 1965) was studied. A high energy electron beam from a linear accelerator is allowed to strike a thick target located in a strong axial magnetic field. A short distance downstream of the target the field makes an abrupt transition to a weaker axial field which continues down the remaining length of the accelerator. Two methods of calculation of the expected system performance are presented: an analysis based on an idealized concept of a uniform short axial field with a discontinuous transition to a weaker uniform field and a numerical ray trace through a field specified by an axial magnetic field plot. The two methods agree quite well provided that after the abrupt transition the field is reasonably uniform. It is shown that a nonuniform field region between the abrupt transition and the final uniform field is undesirable for the case considered the integrated solid angle of acceptance is reduced by a factor of $\sim 1/3$. Assuming the idealized stepped-field configuration the expected performance of the system as a function of its parameters and of the phase space acceptance of the downstream facility was analyzed. With increasing phase space acceptance the accepted positron current is found to increase faster than predicted under an assumption of constant phase space density. It is also shown that the useful source spot size increases with increasing phase space acceptance. A formula is given for optimizing the shape of the phase space acceptance. It is also demonstrated that a low design energy and high axial magnetic fields are desirable for optimum acceptance. An important result is that the useful source spot size is typically 1 to 2 mm diameter, depending on the system parameters. For source spots much larger than this the accepted positron yield is much smaller than that calculated for axial point source. (auth)

7592 (ANL-Trans-413) CYCLOTRON ION SOURCE FOR THE GENERATION OF N^{5+}. Makov, B. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report IAE-1051. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $2.60 fs, $0.86 mf.

An ion source was developed and tested for a cyclotron with a powerful heater-type cathode. Bench tests yielded an N^{5+}-current equal to 100 microampere, from a slit with the dimensions 2×20 mm^2. The cyclotron produced a current of accelerated N^{5+}-ions equal to 1.5 microampere with an energy of 105 MeV. Construction data are given for the ion source. (auth)

7593 AN ON-LINE COMPUTER SYSTEM IN USE WITH LOW-ENERGY NUCLEAR PHYSICS EXPERIMENTS. Gemmell, D. S. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 46: 1-15 (1967).

A description is given of a computing system used on-line with experiments performed at the 4 MeV Van de Graaff and the tandem Van de Graaff accelerators at Argonne National Laboratory. The requirements for the system are listed and the hardware and software obtained to fulfill these requirements are described. Some typical applications of the system are given. (auth)

7594 VARIABLE ENERGY CYCLOTRON. Nucl. Eng., 12: 38-9(Jan. 1967).

A sector-focused cyclotron was built at Harwell to provide intense beams of mono-energetic ions at a wide range of energies. The machine design and uses for radiation damage studies are outlined. (UK)

7595 ELECTRODE SYSTEM OF IMPROVED STRESS UNIFORMITY FOR PRESSURIZED VAN DE GRAAFF GENERATORS. Kiss, A. (Kossuth Lajos Univ., Debrecen, Hung.); Koltay, E.; Szalay, A. Nucl. Instrum. Methods, 46: 130-5(1967).

In order to obtain an electrical field of nearly uniform stress in pressurized Van de Graaff generators a new electrode system, consisting of a high voltage terminal, shaped as third order paraboloid of rotation matching to a spherical calotte and equipotential rings of oval section, is proposed. (auth)

7596 INVESTIGATION OF RADIAL SECTOR-TYPE FFAG ELECTRON SYNCHROTRON (MAXIMUM ENERGY 150 MeV). III. INJECTION. Heinz, W. (Freie Univ., Berlin). Nucl. Instrum. Methods, 46: 16-26(1967). (In German).

For a FFAG accelerator of the radial sector type with an end energy of 150 MeV the radius of injection and the radial aperture of the magnets are evaluated and the limitation at injection due to Liouville's theorem, space charge and tolerable energy spread are considered. Injection below and above transition energy is discussed. The maximum space charge limited current for injection at 200 keV is 2.5 A. The repetition rate is limited to 50 or 100 cps (the last value holds when divided accelerating electrodes are used). The resulting mean output current is 2.5 μA or 5 μA and can be raised by a factor of five when storage and accumulation of particles at a median energy is employed. Injection above transition energy (about 5 MeV) makes possible a repetition rate of 200 to 300 cps. The mean output current is then about 40 μA. A Pierce type injector for a pulse voltage of 200 kV and a pulse current up to 10 A has been constructed and investigated. The pulse current is space charge limited. The energy spread of the injected beam is smaller than $\pm 0.5\%$, the stability of the pulse voltage is better than $\pm 0.5\%$, the stability of the mean output current is $\pm 1\%$. (auth)

7597 PRODUCTION OF NEGATIVE LITHIUM IONS IN A PENNING DISCHARGE. Baumann, H.; Bethge, K.; Heinicke, E. (Univ., Heidelberg). Nucl. Instrum. Methods, 46: 43-4(1967).

A Penning discharge is supported by a $Ne-H_2$ gas mixture into which lithium is evaporated. The analysis of the spectrum of negative charged ions gave the most intensive peak at a mass of 9 which is interpreted as LiH_2^-. Over several hours a beam current of 500 nA was measured. (auth)

7598 MAGNETIC CENTER LOCATION IN MULTIPOLE FIELDS. Cobb, J. K. (Stanford Linear Accelerator Center, Calif.); Muray, J. J. Contract AT(04-3)-400. Nucl. Instrum. Methods, 46: 99-105(1967). (SLAC-PUB-178).

A procedure for optically locating the magnetic center of multipole magnetic lenses is discussed. The technique involves the scattering of plane polarized light through a colloidal suspension of ferrosoferric oxide particles. The mechanism by which the scattering patterns are formed for quadrupoles, sextupoles and octupoles were examined and the mathematical theory that is shown to predict the location and spacing of the patterns in these magnets was developed. (auth)

7599 AXIALLY SYMMETRIC MAGNETIC FIELDS: AN INVESTIGATION ABOUT CONICALLY SHAPED POLE FACES, A GENERAL METHOD TO EVALUATE THE SCALAR POTENTIAL. Bosi, G. (Friedrich Krupp Mess- und Analysentechnik, Bremen). Nucl. Instrum. Methods, 46: 55-60(1967).

An attempt to supply a general procedure to solve problems where axially symmetric magnetostatic fields are involved is presented. Most results apply fairly well to electrostatic fields. In the first part large facilities of shaping iron magnet poles as conical surfaces when field forms are given are stressed. Further sections are devoted to describing an approximation method allowing field forms to be calculated when shapes of poles (or

electrodes) are known. It should be most suitable for field mapping when ion or electron optical lenses are dealt with. (auth)

7600 DETERMINING THE INDEX OF A BETATRON FIELD FROM THE VECTOR POTENTIAL. Sipek, L. (Inst. of Plasma Physics, Czechoslovak Academy of Sciences, Prague). Nucl. Instrum. Methods, 46: 27-8(1967).

Relations are derived for the determination of the field index from the vector potential measured with a set of concentric coils of constant length of winding or with a set of radially equidistant coils of constant number of turns. The method has been applied to the magnetic field of a 15-MeV betatron and gives the index with an accuracy of about 3%. (auth)

7601 INVESTIGATION OF THE EMITTANCE OF A LONG-LIFETIME RF ION SOURCE. Valyi, Laszlo; Gombos, Peter; Roosz, Jozsef. Magyar Tud. Akad. Kozp. Fiz. Kut. Int. Kozlem., 14: 259-65(1966). (In Hungarian).

The emittance of the rf ion source used in the electrostatic accelerator EG-2 was measured at extracting voltages of 2, 2.5, and 3 kV. The measuring technique permitted the ion beam to be separated from that neutralized by charge exchange and the emittance diagram of the ion beam to be plotted. (auth)

7602 NANOSECOND PULSED ION SOURCE. Vorotnikov, P. E.; Zubov, Yu. G.; Molchanov, Yu. D.; Udod, A. A.; Yan'kov, G. B. (Inst. of Nuclear Energy, Moscow). Prib. Tekh. Eksp., No. 5, 37-9(Sept.-Oct. 1966). (In Russian).

Experiments with a pulsed ion source for an electrostatic accelerator showed that by using a low-energy hf source (I ~ 60 μA) and applying ion phase focusing it is possible to develop ion pulses of ~2 nsec at a current of ~1.5 mA and repeating frequency of ~4 Mc. The ion energy spread is 400 eV and with ion current efficiency coefficient of ~25%. (tr-auth)

7603 DEVICE FOR A HIGH-VOLTAGE SCANNING OF ELECTRON AND PROTON BEAMS. Kutakh, V. K.; Neoneta, A. S. (Physico-Technological Inst. of Low Temperatures, Kharkov). Prib. Tekh. Eksp., No. 5, 41-3(Sept.-Oct. 1966). (In Russian).

Linear sawtooth pulse generators were used for electrostatic scanning of electron and proton beams with 50- to 200-keV particles. The pulse amplitudes are adjusted for 500 V to 6 kV and pulse frequencies from 5 kc to 200 C. The reverse pulse rate for 5 kc and 200 C was 10 and 2 μsec, respectively. (tr-auth)

7604 DEVICE FOR DETERMINING DEE-SHIFT IN A CYCLOTRON. Pepuryanu, S. (Inst. of Nuclear Physics, Bucharest). Prib. Tekh. Eksp., No. 5, 39-41(Sept.-Oct. 1966). (In Russian).

A device was designed for the remote determination of the position of the dees in an operating cyclotron. The device consists of a 12 diode recorder and two logometers. The sensitivity of the device is ~0.1 mm. (tr-auth)

7605 ENERGY OF IONS EMITTED FROM A HIGH-FREQUENCY SOURCE. Vorotnikov, P. E.; Zubov, Yu. G.; Molchanov, Yu. D. (Inst. of Nuclear Energy, Moscow). Prib. Tekh. Eksp., No. 5, 33-6(Sept.-Oct. 1966). (In Russian).

A method of supressed potentials was used for measuring the mean energy and energy spread of hydrogen ions emitted from a high-frequency ion source with transverse magnetic field. It was found that with variations in the high-frequency field, gas pressure, anode voltage, and magnetic field, the mean square energy spread is ~8 eV. (tr-auth)

7606 MEASUREMENTS OF CURRENT DENSITY OF PULSED PROTON BEAM. Batalin, V. A.; Moguchev, V. I. (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp., No. 5, 26-32(Sept.-Oct. 1966). (In Russian).

Descriptions are given of a device for measuring current density of a pulsed proton beam in a phase space of transverse coordinates and particle velocities. The device is designed to scan the beam by an alternating electric field placed perpendicular to the beam axis of motion. The device is capable of producing rapid results concerning the phase density variations in the particle pulse along the axis of motion. (tr-auth)

7607 INSTRUMENTAL ASPECTS OF SYNCHROTRON XUV SPECTROSCOPY. Madden, R. P.; Ederer, D. L.; Codling, K. (National Bureau of Standards, Washington, D. C.). Appl. Opt., 6: 31-8(Jan. 1967).

The NBS 180-MeV machine was utilized for gas absorption studies over a four-year period, during which a 3-m grazing incidence spectrograph and monochromator were designed, constructed, and put into operation. The instruments are extremely stable to vibration and temperature variation, and are operated with a slit limited resolution of the order of 0.06 Å. The design principles and features of these instruments are described, and a highly successful prealignment procedure for grazing incidence spectrometers is outlined. The effect of the unusual characteristics of this light source on the illumination and performance of the spectroscopic instruments is discussed. (auth)

7608 IMPROVEMENTS TO A PULSED NEUTRON GENERATOR. Attree, V. H.; Hanna, N. N.; Harris, M. J. (Univ. of Manchester, Eng.). J. Sci. Instrum., 43: 951-2(Dec. 1966).

The peak target current of a SAMES type J, 150-kv accelerator (La Société Anonyme des Machines Electrostatique de Grenoble, France) is increased from 0.5 to 3.0 mA by raising the rf power supplied to the ion source from 75 to 600 w. The push-pull ionizing oscillator is controlled by a radio-link and the accelerator will give neutron pulses of duration from 2 to 1 msec. (auth)

7609 A SUPERCONDUCTING QUADRUPOLE LENS. Kruger, P. G.; Sampson, W. B.; Britton, R. B. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2, 338(Sept. 1966).

Conventional quadrupole lenses, used in beam handling equipment for high-energy nuclear physics and made with iron and copper, provide magnetic fields of about 20 kG and magnetic field gradients of about 2 or 3 kG/cm. On the other hand, Nb_3Sn will operate satisfactorily up to 200 kG and that magnetic field gradients of at least 25 kG/cm can be achieved with this material. Furthermore, since the focal length of a quadrupole lens system is proportional to $[BR/(dB/dr)]^2$, where BR is the magnetic rigidity of the particle to be focused, attempts were made to make a quadrupole lens using current sheets for Nb_3Sn, so that dB/dr is as large as possible. Models of this type of lens were constructed and measurements of B and dB/dr made in the circular aperture of the lens. The models were made by positioning superconducting ribbons on a stainless steel frame, in such a way as to form a square array of 4 mutually perpendicular current sheets. The maximum field gradient achieved was 10 kG/cm, obtained with a current density of 4×10^4 A/cm^2 in the windings. (BBB)

7610 STRONG FOCUSING BY A CORRUGATED MAGNETIC FIELD. Khapaev, M. M. pp 75-9 of Chislennyye Metody Resheniya Zadach Matematicheskoy Fiziki, 1966. Moscow. (In Russian).

The focusing properties of corrugated magnetic fields were investigated. Equations are obtained for determining betatron oscillation frequencies, and the boundary is established for the stability region of fast charged particle motion in such fields. Making certain assumptions which permit the use of averaging methods, a more detailed description of particle motion is obtained and adiabatic invariants describing nonlinear betatron oscillations and their frequencies are constructed. It is noted that the magnetic strong-focusing system considered here might be used in weak-focusing accelerators to improve the focusing, as well as independently in linear accelerators. (CFSTI)

7611 PROPOSAL FOR DETECTING THE POLARIZATION OF SLOW PROTONS AND DEUTERONS. Clausnitzer, G.; Fick, D. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods, 47: 171-2(Jan. 1967).

The method for detecting the polarization degree of a proton or deuteron beam is explained for the case of protons. The method is based on converting a portion of the protons (or deuterons) into metastable hydrogen atoms by charge exchange in an alkali metal vapor and observing the intensity of the Lyman-α quanta after quenching the beam in suitable electric and magnetic fields. The analyzing system used for the circularly polarized Lyman-α light is shown. (J.F.P.)

7612 IMPROVED NON-INTERCEPTING ACCELERATOR BEAM POSITION SENSOR. Dorikens-Vanpraet, L.; Van Camp, K.; Dorikens, M.; Callebaut, D. (Univ., Ghent). Nucl. Instrum. Methods, 47: 58-60(Jan. 1967).

The non-intercepting beam position sensor, consisting of two sets of pick-up coils, over which trimming capacitors are added, is an improved version of the one proposed by Johnson et al. The modification results in a nearly perfect zero-signal for a centrally located beam. Calculations including the stray capacitance of the coils are sketched. The linearity and sensitivity of the system are very satisfactory. (auth)

7613 HIGH CURRENT PULSED ELECTRON SOURCE: VAN DE GRAAFF. Ramler, W. J.; Johnson, K.; Klippert, T. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 47: 23-8(Jan. 1967).

An electron gun and pulser were developed to produce high current pulses of nanosecond duration. When mounted on the ht terminal of a 3 MeV electron Van de Graaff, 5 A pulses were obtained for time durations of 1 to 100 ns. Corresponding beam area without external focusing is about 0.15 cm^2. (auth)

7614 A CYCLOTRON IS PUT INTO OPERATION IN KAZAKHSTAN. Nemenov, L. M.; Anisimov, O. K.; Arzumanov, A. A.;

(and others). Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 3-15(1966). (In Russian).

A cyclotron of the U-150-2 series, was installed in the Institute of Nuclear Physics, AS KazSSR. This cyclotron is designed for performing nuclear research with the aid of accelerated protons, deuterons, α particles, multiply charged ions, and fast neutrons, and to produce artificial radioactive isotopes as well. It is encased in a concrete shielding and the diameter of its electromagnet poles is 150 cm. The charged particles are accelerated in the vacuum chamber and, with the aid of an electrostatic deflecting system, focused into a beam and guided over a distance of ~24 m to the experimental room, where they are focused on the target. Measurements of particle energies showed that, after some additional modifications of this cyclotron, protons may be accelerated to 20 MeV; deuterons, to 24 MeV; α particles, to 48 MeV; and six-charge carbon ions, to 140 MeV. (JPRS)

7615 RADIAL FOCUSING OF ELECTRONS BY A TRANSAXIAL ALTERNATING MAGNETIC FIELD. Sidorko, P. I. (Chernigivs Pedagogical Inst., USSR). Ukr. Fiz. Zh., 11: 1231-4 (Nov. 1966). (In Ukrainian).

It is shown that a combined electrostatic field and an alternating sinusoidal magnetic field, both of which have a symmetry plane perpendicular to the axis, can form a disk-type electron beam provided the alternating field is quasistationary. A mathematical relation is found between this disk-type beam and the corpuscular-optical properties of a thin lens. (G.O.Y.)

7616 HIGH POWER RF ION SOURCE. D'yachkov, B. A.; Nasonov, A. V. Prib. Tekh. Eksp., No. 4, 32-5(July-Aug. 1966). (In Russian).

The development of a new ion source with hydrogen ion current up to 10 mA is described. The source has a long life and relatively little hydrogen consumption. The source was tested under these two sets of conditions: (1) resonance, 15 Mc, 20 Oe, 1200 V, 300-400 W in the discharge; and (2) resonance, 36 Mc, 60 Oe, 2500 V, 100-150 W in the discharge. The ion beam composition was varied by changing the pressure in the discharge chamber. Lower pressures resulted in higher H_2^+ content while higher pressures yielded higher H_3^+ content; the proton content was at best 50%. Under different conditions the proton content was brought up to 80% with a hydrogen consumption of 100 cc/hr. After 500 hours the chamber contamination was still low and the source continued its stable operation. (ATD)

7617 TRANSISTORIZED PREAMPLIFIER FOR SIGNAL ELECTRODES. Kazanskii, L. N.; Samylkin, N. I.; Yablokov, B. N. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 4, 102-4(July-Aug. 1966). (In Russian).

A signal electrode and transistorized preamplifier with automatic feeding were constructed in order to study the efficiency of a single unit injection into a ring phasotron and the beam instability in betatron acceleration during multistage injection. With cable load 150 ohms, the preamplifier coefficient is ~9, the penetration band is 0.6 to 40 mH_3. (tr-auth)

7618 LIQUID HYDROGEN TARGET. Aleksandrov, Yu. M.; Zinevich, A. N.; Leikin, E. M. Tr. Fiz. Inst., Akad. Nauk SSSR, 34: 206-12(1966). (In Russian).

A liquid hydrogen target with high-vacuum thermal insulation is described. (D.C.W.)

7619 METHOD OF POLARIZING IONS, AND SOURCES OF POLARIZED IONS, NOTABLY PROTONS AND DEUTERONS, OBTAINED THEREFROM. Abragam, Anatole; Beurtey, Rene; Papineau, Andre; Thirion, Jacques; Winter, Jacques Michel (to Commissariat a l'Energie Atomique). U. S. Patent 3,286,162. Nov. 15, 1966. Priority date July 28, 1962, France.

A method is described which comprises steps of conveying particles in the form of atomic jets, separating the atoms in the jet according to the value of their electron spin, and inducing magnetic dipolar transitions by means of a high-frequency electromagnetic field at the frequency of the transitions in the presence of a magnetic field unmodulated in time having a nearly linear gradient along the direction of propagation of the atoms, at right angles to this direction, according to the so-called adiabatic passage method. This method is characterized essentially in that the average value of the unmodulated field is low enough to cause the variation in the internal energy of the atom is a practically linear function of magnetic field from zero value to the average value, for all permissible quantum states for the electron and nuclear spins. (B.G.D.)

7620 PLASMA ION SOURCE HAVING APERTURED EXTRACTOR CATHODE. Wood, James David London Hedley; (to United Kingdom Atomic Energy Authority). U. S. Patent 3,281,617. Oct. 25, 1966. Priority date Feb. 20, 1962, Great Britain.

A plasma ion source is described, which comprises a cathode, an extractor cathode spaced from the cathode and having an aperture therein, an anode positioned between the cathode and the extractor cathode and separated by a gap, and a screen negative electrode positioned about the cathode and external to the plasma, and extending in a direction towards the extractor cathode to apply an electric field to the gap between the cathode and the anode. (B.G.D.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 6096, 6097, 6359, 7142, 7153, 7320, 7361, 7452, 7570, 7572, 7608, 7694, and 7851.

7621 (AD-638024) COMPLEMENTARY VARIATIONAL PRINCIPLES IN NEUTRON DIFFUSION THEORY. Arthurs, A. M. (Wisconsin Univ., Madison. Theoretical Chemistry Inst.). Aug. 24, 1966. Contract DA-11-022-ORD-2059. 13p. (WIS-TCI-184). CFSTI $3.00 cy, $0.65 mn.

Complementary variational principles associated with neutron diffusion in solids are presented. The resulting formulas are used to derive new expressions which provide upper and lower bounds for the absorption probability. (auth)

7622 (AECD-EP-13) STATISTICAL METHOD OF NEUTRON TRANSPORT IN ABSORBING MEDIA. Ahsan, M. (Atomic Energy Centre, Dacca (Pakistan). Experimental Physics Div.). June 1966. 9p. Dep. mn.

The problem of neutron transport in absorbing media was studied using a statistical model. The purpose was to obtain the neutron energy spectrum, for a given monoenergetic source, as function of space. The advantage in the results obtained is the simplicity and directness of the method so that many problems can now be solved easily. (auth)

7623 (AECL-1671) HEX: A COMPUTER PROGRAM FOR SOLVING THE TWO-GROUP DIFFUSION EQUATION IN HEXAGONAL GEOMETRY. Fowler, J. K.; Kennedy, J. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1962. 40p. (CRT-1130) Dep. mn. AECL $1.00.

HEX is a program for the Bendix G-20 computer that solves the two-group neutron diffusion equations. The finite-difference approximations are solved on a two-dimensional hexagonal mesh. The program is therefore particularly designed for calculations concerning physical systems such as the NRX and NRU reactors that possess this symmetry. The description of the geometry has been made flexible enough to admit any convex region (and many re-entrant ones), with arbitrary boundary conditions on the normal derivative. The boundary need not run through points of the mesh. The parts of the program that involve the physical parameters describing neutron diffusion have been confined to a single subroutine. This can be replaced if the basic program is to be used for other types of calculation. (auth)

7624 (AECL-1996(Suppl.)) MODIFICATIONS TO THE COMPUTER CODE EPITHET. Halsall, M. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1966. 12p. (CRRP-1197A). Dep. mn. AECL $0.50.

The computer code EPITHET was developed further. Fission-spectrum sources and inelastic-scattering data may now be specified in the input, and corrections for forward scattering from light nuclei may be made automatically. Fast fission ratios, neutron age, and advantage factors can now be calculated. A complete description of the input to EPITHET and a brief account of the changes which have been made since 1964 are presented. (auth)

7625 (AEET-246) KERN AND PAR PROGRAMS FOR COMPUTING SCATTERING KERNELS IN H_2O, D_2O, AND POLYETHYLENE. Lawande, S. V. (Atomic Energy Establishment, Trombay (India)). 1966. 14p. Dep. mn.

A program for the calculation of kernels for thermal neutrons scattered inelastically from chemically bound target nuclei in moderators is described. The main program that achieves this is called KERN. The two auxiliary programs, PAR I and PAR II, compute the specific input parameters for KERN according to either the Nelkin–Honeck model for H_2O and D_2O or the Goldman model for polyethylene. The programs use FORTRAN language. (auth)

7626 (ANL-7112) XLIBIT: ANL CROSS-SECTION LIBRARY CODE. Sparck, S. D. (Argonne National Lab., Ill.). Feb. 1966. Contract W-31-109-eng-38. 291p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The XLIBIT code is a part of a project to develop one- and two-dimensional neutron diffusion theory and Sn transport theory programs for the CDC-3600 computer. The code is designed to: prepare neutron cross-section library tape; modify an existing cross-section library tape; duplicate an existing cross section library tape; print all or a portion of the cross-section data on the library tape; and punch cross-section decks for all or a portion of the data on the library tape. (S.F.L.)

7627 (ANL-7223) MACH 1: A ONE-DIMENSIONAL DIFFUSION-THEORY PACKAGE. Meneley, D. A.; Kvitek, L. C.; O'Shea, D. M. (Argonne National Lab., Ill.). June 1966. Contract W-31-109-eng-38. 71p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A computer program, MACH 1, for single-step calculations of reactor parameters is described. The program solves the coupled set of one-dimensional multigroup diffusion equations in cylindrical, slab, or spherical coordinates. The program is written in FORTRAN for the CDC-3600 computer with 64-K core storage. (D.C.W.)

7628 (GA-7283) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period Ending June 30, 1966. Antunez, H.; Beyster, J. R.; Borgonovi, G.; (and others) (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 22, 1966. Contract AT(04-3)-167. 94p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Progress is reported on improved utilization of the GASKET-FLANGE Codes. The FLANGE Code calculates neutron scattering kernels from scattering law input. The GASKET Code is used to generate scattering laws (FLANGE input) to correct previous errors or to incorporate improved dynamical models for various moderators. Studies were made of multiple neutron scattering in H_2O. This work is intended to make the observed and calculated scattering laws self-consistent. Scattering laws for D_2O and BeO were generated by means of GASKET. The phonon spectrum of BeO was calculated and was used to generate a scattering kernel. Thermal neutron spectra in diphenyl and at a diphenyl-D_2O interface were measured. The leakage neutron spectrum from the Accelerator Pulsed Fast Assembly (APFA) was measured by the pulsed-source, time-of-flight technique and was compared with Sn transport calculations. A large-volume plastic scintillator is being constructed for use in neutron detection via (n,γ) capture reactions. The specific purpose of the detector is the measurement of neutron flux with high efficiency and near-zero background at neutron energies ranging from 100 eV up to 15 MeV. A description is given of a 200-meter neutron flight path. (S.F.L.)

7629 (GEAP-4472) USER REQUIREMENTS FOR CROSS SECTIONS IN THE ENERGY RANGE FROM 100 eV TO 100 keV. Greebler, P.; Hutchins, B. A. (General Electric Co., San Jose, Calif. Advanced Products Operation). June 1966. Contract AT(04-3)-189. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The sensitivity of important physics parameters of large fast power reactors to uncertainties in the cross-section data between 0.1 and 100 keV was evaluated. Reactors using Pu–U and Th–U fuel cycles, carbide and oxide fuels, sodium and steam coolants, and a broad variation in neutron leakage and spectrum were considered. The cross-section accuracies required for calculations of fissile mass, breeding ratio, Doppler coefficient, and sodium void reactivity were determined. (D.C.W.)

7630 (GEMP-456) UPDONC CODE (UPDATE OF NUCLEAR 19-GROUP CROSS SECTIONS). Edwards, M. R. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Dec. 5, 1966. Contract AT(40-1)-2847. 86p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A description is given of UPDONC (NMP-861) update of nuclear cross-sections, which is a GE-625 code written in FORTRAN IV which prepares and/or maintains a tape containing 19-group cross sections plus those for 7 temperatures in the thermal region. This tape is used as a source of nuclear data input to other computer programs. At GE-NMPO, it is currently being used by GRASS, ZIP-III, GEORGE-III, and C-VII. The tape prepared by UPDONC may contain as many as four hundred sets (materials) of cross sections, each set having five types and the source. In addition to updating the tape, UPDONC optionally mixes, lists, punches, and plots cross sections. The running time of this code varies with the size of the tape and the number of options requested. (auth)

7631 (INP-497/PS) THERMOSTAT FOR NEUTRON CROSS-SECTION MEASUREMENTS WITHIN THE RANGE 196 DEG C TO 200 DEG C. Sudnik-Hrynkiewicz, M.; Olejarczyk, W.; Zieleniewski, R.; Szkatula, A.; Janik, J. A.; Bajorek, A. (Institute of Nuclear Physics, Krakow (Poland)). Sept. 1966. 10p. Dep.

A thermostat for measurements of neutron cross sections of thin samples with large areas (up to 400 cm^2) at temperatures within the range −196 to 200°C is described. Constructional details, principle of temperature stabilization, control, and remarks concerning preliminary exploitation of the thermostat data are given. (auth)

7632 (KAPL-P-3179) COMPARISON OF SCATTERING LAW DATA AND CALCULATIONS FOR WATER. Kirouac, G. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). [1966]. Contract W-31-109-eng-52. 23p. (CONF-661001-29). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

A survey of some of the more recent neutron scattering models for light water are presented, and an extensive comparison of these models with experimental scattering-law data which has been corrected for multiple scattering is included. (auth)

7633 (LA-3560) NEUTRON RESONANCES AND REACTIVITY. Mills, Carroll B. (Los Alamos Scientific Lab., N. Mex.). June 15, 1966. Contract W-7405-eng-36. 72p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A simple and consistent treatment of neutron cross sections is presented for use in reactor physics. A review is given of the elementary isolated resonance equations, and two codes are presented for the resolved and unresolved resonance regions. The resolved resonances are integrated over the Boltzmann velocity distribution function for absorber atoms at a sufficient number of neutron energy points so that the Doppler and moderator scattering effects can be computed accurately and rapidly. Resonance interference and scattering effects are explicit. Further, weighting functions specific to narrow and wide resonances, with and without a reactor neutron slowing down density weight, are used, and the resulting values are punched on standard cross-section data cards for reactor oriented calculations. The unresolved resonances are treated in very much the same way, but with an average of resonance neutron reduced width and position selected by Monte Carlo techniques. The results are presented for a few perturbation-theory calculations of material reactivity (reactor center and a radial distribution) for elements of interest to the LASL N-Division. Both Argonne National Laboratory (ZPR-III) and Los Alamos (Phoebus 1 and 2) flux adjoints are used for cross-section evaluation, and in one illustrative case these resulted in a significant improvement. Results are given of an application of summary methods for neutron cross-section averaging from basic data. The results presented are preliminary, but indicate that this area of activity should be very fruitful, and should provide a great simplification of specific cross-section tabulation in the field of reactor physics. (auth)

7634 (NASA-TN-D-3695) AGES OF PLUTONIUM-BERYLLIUM NEUTRONS IN TUNGSTEN-WATER MEDIA. Shook, Donald F.; Alexander, Roger L.; Bogart, Donald; Krueger, Margery (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1966. 21p. CFSTI $1.00 cy, $0.50 mn.

The spatial distributions of neutrons slowing down from (Pu–Be) sources as indicated by Cd-covered In foil activities were measured in water and in mixtures of metallic W rods and water. The effects of the finite sizes of the sources on the shapes of the distributions were experimentally determined. The effects of the heterogeneity and finite size of the slowing-down media were also evaluated. Experimental ages obtained with a 5-curie source corrected to a point source were 50.5 ± 2 cm^2 in water and 46.8 ± 3 and 40.6 ± 3 cm^2 in mixtures of 15 W–85 water and 23.7 W–76.3 water percent by volume, respectively. An age of 53.0 ± 3 cm^2 was determined for a 1-curie Pu-Be source in water. The measurements confirm a reduction in age due to W with its large inelastic scattering cross sections. Calculated and measured ages agreed for water, but the calculated ages were an average of 15% lower than the measured ages for the W-water mixtures. Possible reasons for the lower calculated ages are the uncertainties in high-energy W cross sections and the use of the evaporation model to represent inelastic scattering above a neutron energy of 1.8 MeV. (auth)

7635 (ORNL-TM-1610) TACS: A CODE TO CALCULATE FAST REACTOR GROUP CROSS SECTIONS FROM POINT DATA FOR PRIMARY USE IN S_n TRANSPORT CODES. Smith, O. L. (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 91p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A code is described which calculates the group-averaged cross sections required for fast reactor analysis. The cross section formulations are oriented toward use in the S_n transport codes of Carlson, although some of the formulations may have a more general use. The code evaluates isotropic and linear anisotropic elastic scattering, inelastic scattering according to the individual level model and the evaporation model, non-resonance absorption and fission, and (n,2n) reactions. Group-averaged cross sections are generated from point data input on cards. An arbitrary group structure of up to 500 groups is allowed. A number of flux weighting options are built into the code, or the user may read in on cards any flux he wishes. Output may be punched on cards in a format consistent with the Fortran versions of the S_n codes. Considerable mathematical development is given in the cross section formulations. The code is written in Fortran II for the IBM 7090 computer. (auth)

7636 (ORNL-TM-1674) ACTIVT: AN 05R MONTE CARLO ANALYSIS ROUTINE FOR CALCULATION OF ACTIVATION. Morrison, G. W.; Mihalczo, J. T.; Irving, D. C. (Oak Ridge National Lab., Tenn.). Oct. 3, 1966. Contract W-7405-eng-26. 19p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The ACTIVT FORTRAN subroutine for analyzing the collision tapes from the 05R Monte Carlo neutron transport code to obtain the activation rates for a given reaction in a particular region of a reactor is described. As many as ten different types of activation rates may be calculated simultaneously. At the present time the energy range for the calculation is specified as input with a maximum of 32 groups per factor of two in energy used for the averaged cross sections. The standard deviations for each activation rate are also determined. (auth)

7637 (ORNL-TM-1699) RAFFLE: A MONTE CARLO CODE FOR CALCULATION OF FIRST FLIGHT COLLISION PROBABILITIES. Hermann, O. W.; Carlsmith, R. S. (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The computer program RAFFLE which calculates neutron first flight collision probabilities for a wide variety of three-dimensional cell geometry configurations is described. The outer boundaries of the cell cross section may be circular, square, or hexagonal; and the cell may contain annular regions and/or clusters of rods. The Monte Carlo method is used, in which neutron histories are started at random within one material and are continued until a collision occurs. Versions of the code are available for IBM-7090 and IBM System/360 computers. (auth)

7638 (WAPD-TM-609) A SIMPLE METHOD TO IMPROVE THE EFFICIENCY OF THE Σ_a/Σ_t ESTIMATOR IN CERTAIN MONTE CARLO PROGRAMS. Steen, N. M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1966. Contract AT-11-1-GEN-14. 13p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The Σ_a/Σ_t estimator (often used in Monte Carlo programs to estimate neutron capture rates in assemblies or reactor materials) is inefficient in regions having a high probability of neutron entry but a low collision probability. A simple method is described to enhance the efficiency of this estimator in such regions by fictitiously increasing the optical thickness. Proof is given that this method will not bias the capture estimates or the flux, and examples are provided to show the improvement that may be achieved. (auth)

7639 (WAPD-TM-610) VARIATIONAL PRINCIPLE FOR THE NEUTRON DIFFUSION EQUATION USING DISCONTINUOUS TRIAL FUNCTIONS. Buslik, A. J. (Bettis Atomic Power Lab., Pittsburgh, Pa. Oct. 1966. Contract AT(11-1)-Gen-14. 20p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A variational principle for the neutron diffusion equation which permits the use of discontinuous trial fluxes is presented. The principle is based on the method of Lagrange multipliers. Applications of the principle to problems of axial synthesis are given, and the principle is compared to that of Selengut and Wachspress. (auth)

7640 (WAPD-TM-645) DIFFERENCE EQUATIONS FOR THE NEUTRON DIFFUSION EQUATIONS IN HEXAGONAL GEOMETRY. Kellogg, R. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1966. Contract AT(11-1)-Gen-14. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The difference equations used in the hexagonal geometry option of the PDQ-7 program are derived. These difference equations are interpreted as belonging to a whole family of hexagonal difference approximations which in turn are derived using discontinuous trial functions. The truncation error of the PDQ-7 hexagonal difference equations is also discussed. (auth)

7641 (ORNL-tr-1377) PROPAGATION OF NEUTRONS TREATED BY THE AGE THEORY: MALAGA PROGRAM. Brisbois, Jacques; Devillers, Christian; Rosa, Therese (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CEA-N-593. 59p. Dep. mn. JCL $5.60 fs, $1.97 mf.

The computer program MALAGA SEPP/077, which treats the propagation of neutrons in a laterally infinite mass or in a mass of rectangular cross section, is described. The structure can be axially finite, semi-infinite, or doubly infinite, containing a plane source; or it can be separated by a plane into two semi-infinite media where the ratio of the diffusion coefficients as well as the ratio of ages in the two media does not vary as a function of lethargy. In the latter case, sources are distributed in one of the two media. The program can also be used to study ducted structures. (D.C.W.)

7642 ABSOLUTE CALIBRATION OF NEUTRON SOURCES BY $MnSO_4$ ACTIVATION. Andrasi, Andor; Deme, Sandor; Nagy, Judit. Magyar Tud. Akad. Kozp. Fiz. Kut. Int. Kozlem., 14: 267-80(1966). (In Hungarian).

The absolute neutron emission rate was determined for fast neutron sources from the activation of $MnSO_4$ solutions. The ^{56}Mn activity produced in the solution was measured using a scintillation counter assembly calibrated with a high specific activity ^{56}Mn solution standardized previously by $4\pi\beta$ counting. With the use of this method, the neutron emission rate of a Ra–Be source was measured to be 3.35×10^6 sec. The standard error of the measurement was ±1.5%. The measured value is 3% less than the rated yield of the source. The measuring technique, the calculating process, and the factors affecting the accuracy of the method are discussed. (auth)

7643 SYSTEM OF MAGNETIZED COBALT MIRRORS USED TO PRODUCE AN INTENSE BEAM OF POLARIZED THERMAL NEUTRONS. Abrahams, K.; Ratynski, W.; Stecher-Rasmussen, F.; Warming, E. (Danish AEC Research Establishment, Risoe, Denmark). Nucl. Instrum. Methods, 45: 293-300(1966).

A description is given of a system of magnetized cobalt mirrors by means of which a $(75 \pm 2)\%$ polarized beam of thermal neutrons of flux density $(2 \pm 0.2) \times 10^7$ n/cm^2·sec is obtained from a neutron beam extracted from the 10 MW DR 3 reactor of Risö. The polarized beam was focused on a spot at a distance of 3.5 m from the mirror system. The equipment described has been used for experiments on neutron capture gamma radiation. Theoretical estimates of polarization, energy spectrum and intensity are compared with experimental results. (auth)

7644 THE COLD NEUTRON FACILITY AT THE FiR 1. Tunkelo, E.; Palmgren, A. (Technical Univ. of Helsinki). Nucl. Instrum. Methods, 46: 266-74(1967).

A description is given of the cold neutron facility at the FiR 1 (Triga Mark II, 100 kW). The facility utilizes a refrigerated moderator in a tangential beam tube traversing the graphite reflector of the reactor. The beryllium-filtered neutron beam is chopped before reaching the sample. The detectors are mounted on movable arms allowing scattering angles between 0 and 130° to be studied. The performance of the facility is characterized by a beryllium-filtered cold neutron intensity of 6×10^6/sec with a beam of 30×40 mm^2, combined with a very low room background. The results of a representative measurement are given. (auth)

7645 THEORY OF CRITICAL MAGNETIC SCATTERING OF NEUTRONS BY FERROMAGNET AND ANTIFERROMAGNET. Oguchi, Takehiko; Ono, Ikuo (Tokyo Metropolitan Univ.). J. Phys. Soc. Jap., 21: 2178-93(Nov. 1966).

The statistical theory of the localized model of ferromagnetism has been developed using the effective Hamiltonian method. The present method is an extensive application of that by Strieb, Callen, and Horwitz. The result is reduced to that of the Bethe approximation in the Ising model in one limit, and to that of the constant coupling approximation in the Heisenberg model in the other limit. The method has been generalized to calculate the spin pair correlation functions, which are very important for the cross section in the critical magnetic scattering of neutrons. The spin pair correlation functions have been obtained in Ornstein–Zernike type in the vicinity of the critical temperature. The results obtained by Elliott and Marshall, Mori and Kawasaki, and Tahir–Kheli and Callen are compared with the present results and are criticized. The present results are in good agreement with the experimental results. The method has been extended to the antiferromagnetic case. (auth)

7646 SPECTRAL ESTIMATION AND MULTIPLE SCALING. Layno, Salvador B. (Boeing Co., Seattle); Babb, Albert L. Trans. Amer. Nucl. Soc., 9: 442(Oct.-Nov. 1966).

7647 HALF-RANGE ORTHOGONALITY RELATIONS FOR NEUTRON TRANSPORT WITH A SEPARABLE KERNEL. McCormick, N. J. (Univ. of Washington, Seattle); Kuscer, I. Trans. Amer. Nucl. Soc., 9: 444-5(Oct.-Nov. 1966).

7648 FLUX FROM A POINT SOURCE OF NEUTRONS IN TWO ADJACENT, DISSIMILAR MEDIA. Erdmann, R. C. (Univ. of California, Los Angeles). Trans. Amer. Nucl. Soc., 9: 443-4 (Oct.-Nov. 1966).

7649 NEUTRON DIFFUSION IN MEDIA WITH HOLES. Bachman, William H.; Jacobs, Alan M. (Pennsylvania State Univ., University Park). Trans. Amer. Nucl. Soc., 9: 442-3 (Oct.-Nov. 1966).

7650 A COMPARISON OF SCATTERING LAW DATA AND CALCULATIONS FOR WATER. Kirouac, G. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 9: 495(Oct.-Nov. 1966).

7651 MULTIPLE SCATTERING CORRECTIONS TO DOUBLE-DIFFERENTIAL CROSS-SECTION MEASUREMENTS FOR ROOM-TEMPERATURE WATER. Slaggie, E. Leo (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 494(Oct.-Nov. 1966).

7652 SOLUTION OF THE SPACE-TIME NEUTRON-GROUP DIFFUSION EQUATIONS BY A TIME-DISCONTINUOUS SYNTHESIS METHOD. Yasinsky, J. B. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 456-7(Oct.-Nov. 1966).

7653 MULTIPLE SCALING: ITS THEORY AND APPLICATION TO NEUTRON-TRANSPORT PROBLEMS. Layno, Salvador B. (Boeing Co., Seattle); Babb, Albert L. Trans. Amer. Nucl. Soc., 9: 441-2(Oct.-Nov. 1966).

7654 ANALYTICAL DEVELOPMENT OF S_N THEORY. Finucane, J. S. (Univ. of California, Berkeley); Selengut, D. S. Trans. Amer. Nucl. Soc., 9: 432(Oct.-Nov. 1966).

7655 A DOUBLE P_N METHOD FOR SPHERES AND CYLINDERS. Schmidt, E.; Gelbard, E. M. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 432-3 (Oct.-Nov. 1966).

7656 THE P_L SOLUTION IN A NONCYLINDRICAL CELL CONTAINING A CYLINDRICAL FUEL ROD. Adir, Joel (New York Univ., New York). Trans. Amer. Nucl. Soc., 9: 433-4 (Oct.-Nov. 1966).

7657 NUMERICAL COMPARISON OF DIFFERENT TYPES OF VACUUM BOUNDARY CONDITIONS FOR THE P_N APPROXIMATION. Pellaud, Bruno (New York Univ., New York). Trans. Amer. Nucl. Soc., 9: 434-5(Oct.-Nov. 1966).

7658 EXTRAPOLATION LENGTHS FOR HIGHLY ANISOTROPIC SCATTERING. Mourad, S. A. (Univ. of California, Berkeley); Selengut, D. S. Trans. Amer. Nucl. Soc., 9: 435-6 (Oct.-Nov. 1966).

7659 EXTRAPOLATION DISTANCE FOR AN INFINITE BLACK CYLINDER IN AN ABSORBING MEDIUM WITH ANISOTROPIC SCATTERING, AND WITH UNIFORM SOURCES OR WITHOUT SOURCES. Pellaud, Bruno (New York Univ., New York). Trans. Amer. Nucl. Soc., 9: 436-7(Oct.-Nov. 1966).

7660 THE APPLICATION OF INVARIANT IMBEDDING THEORY TO GREEN'S FUNCTIONS. Timmons, D. H.; Mingle, J. O. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc., 9: 437(Oct.-Nov. 1966).

7661 DERIVATION OF A POINT KERNEL FOR NEUTRON ATTENUATION. Krug, H. E.; Olhoeft, J. E. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 364-5 (Oct.-Nov. 1966).

7662 ERROR BOUNDS FOR APPROXIMATE SOLUTIONS OF THE NEUTRON-GROUP DIFFUSION EQUATIONS. Yasinsky, J. B. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 471-2(Oct.-Nov. 1966).

7663 TWO-DIMENSIONAL APPLICATION OF AN ITERATIVE METHOD FOR SOLVING THE NEUTRON TRANSPORT EQUATION WITH ANISOTROPIC SCATTERING. Crawford, Bruce W.; Friedman, Jack P. (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 9: 472-3(Oct.-Nov. 1966).

7664 STABLE METHODS OF MATRIX FACTORIZATION FOR BLOCK-TRI-DIAGONAL MATRICES WITH APPLICATIONS TO MULTIGROUP DIFFUSION EQUATIONS. Froehlich, Reimar (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 475(Oct.-Nov. 1966).

7665 APPLICATIONS OF THE TRANSFER MATRIX FORMULATION TO ISOTROPIC SCATTERING PROBLEMS. Aronson, Raphael (New York Univ., New York). Trans. Amer. Nucl. Soc., 9: 476-7(Oct.-Nov. 1966).

7666 TWO-REGION TWO-GROUP THEORY FOR HAND CALCULATIONS. Emon, Donald E. (Texas A and M Univ., College Station). Trans. Amer. Nucl. Soc., 9: 605(Oct.-Nov. 1966).

7667 PROBLEMS IN NEUTRON SLOWING BY INELASTIC SCATTERING. Miley, G. H. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc., 9: 604-5(Oct.-Nov. 1966).

7668 NEUTRON-ENERGY SPECTRA OF ^{239}PuBe, ^{238}PuF, AND ^{238}Pu^{18}O(α,n) SOURCES. Anderson, M. Edward (Monsanto Research Corp., Miamisburg, Ohio). Trans. Amer. Nucl. Soc., 9: 600(Oct.-Nov. 1966).

7669 ANALYSIS OF A NEUTRON PULSE IN A SLAB USING THE RECIPROCITY PRINCIPLE. McCormick, N. J. (Univ. of

Washington, Seattle); Kuscer, I. Trans. Amer. Nucl. Soc., 9: 512-13(Oct.-Nov. 1966).

7670 TIME-DEPENDENT SPECTRA IN POLYETHYLENE. Menzel, J. H. (Rensselaer Polytechnic Inst., Troy, N. Y.); Gozani, T.; Malaviya, B. K.; Gaerttner, E. R.; Fluharty, R. G.; Simpson, F.; Harker, Y. Trans. Amer. Nucl. Soc., 9: 512(Oct.-Nov. 1966).

7671 ENERGY CORRELATION METHOD FOR THE DETERMINATION OF SLOWING DOWN TIMES. Albrecht, Robert W.; Williamson, Theodore J. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 9: 509-10(Oct.-Nov. 1966).

7672 A TREATMENT OF THE SPATIAL DEPENDENCE OF THE DOPPLER EFFECT. Sha, William T. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 505-6(Oct.-Nov. 1966).

7673 RESONANCE OVERLAP IN NATURAL TUNGSTEN. Westfall, Robert M. (Lewis Research Center, Cleveland). Trans Amer. Nucl. Soc., 9: 504-5(Oct.-Nov. 1966).

7674 EFFECTS OF ACCIDENTAL AND SEQUENCE OVERLAP ON EFFECTIVE CROSS SECTIONS AND DOPPLER COEFFICIENTS FOR U-Pu MIXTURES. Graves, Charles C. (Catholic Univ. of America, Washington, D. C.). Trans. Amer. Nucl. Soc., 9: 502-3(Oct.-Nov. 1966).

7675 A REFINEMENT IN THE APPLICATION OF SUPERPOSITION TO MONTE CARLO RESONANCE-ESCAPE CALCULATIONS. Gelbard, E. M.; Spanier, J.; Anderson, B. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 501-2(Oct.-Nov. 1966).

7676 REMOVAL OF THE FLAT-SOURCE RESTRICTION IN SLAB-GEOMETRY RESONANCE-ABSORPTION CALCULATIONS. Cohen, S. C. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 500-1(Oct.-Nov. 1966).

7677 EFFECT OF SOURCE DISTRIBUTION ON RESONANCE INTEGRALS. deLoach, A. C.; Suich, J. E. (E. I. duPont de Nemours, Aiken, S. C.). Trans. Amer. Nucl. Soc., 9: 500(Oct.-Nov. 1966).

7678 PULSED-NEUTRON MEASUREMENTS IN CARBON BLACK. Herbst, J. J. (New York Univ., Bronx, N. Y.). Trans. Amer. Nucl. Soc., 9: 499(Oct.-Nov. 1966).

7679 TOTAL THERMAL CROSS SECTION OF CARBON BLACK. Herbst, J. J. (New York Univ., Bronx, N. Y.). Trans. Amer. Nucl. Soc., 9: 498-9(Oct.-Nov. 1966).

7680 NEUTRON INELASTIC SCATTERING BY ZIRCONIUM HYDRIDE. Pan, S. S.; Moore, W. E.; Yeater, M. L. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 9: 495-6(Oct.-Nov. 1966).

7681 CALCULATION OF DOPPLER TEMPERATURE COEFFICIENT FOR INDIVIDUAL RESONANCES IN HOMOGENEOUS MEDIUM. Bulavin, P. E.; Toshinskii, G. I. At. Energ. (USSR), 21: 54-6(July 1966). (In Russian).

A calculation method was developed for estimating the neutron Doppler temperature coefficient in the self-shielding of individual resonances in homogeneous media. (R.V.J.)

7682 ITERATIVE SOLUTION METHOD FOR THE NEUTRON TRANSPORT EQUATION WITH ANISOTROPIC SCATTERING. Crawford, Bruce Winston. Berkeley, Calif., Univ. of California, 1966. 303p.

Thesis.

An iterative solution method for the neutron transport equation with anisotropic scattering is presented. The method is developed to treat the neutron flux distribution as a function of the independent variables of position, neutron direction, and neutron speed for an arbitrary geometry problem. However, emphasis in application is directed towards the solution of the one-dimensional monoenergetic problem with an anisotropic scattering kernel. Properties of the neutron transport equation and its solution are established. Properties of the anisotropic scattering kernel are discussed. Convergence theorems and error estimates for the iterative solution are presented. Some formal extensions to a wider class of transport problems are indicated. The iterative solution method permits one to express the solution of the transport equation with an anisotropic scattering kernel as a sequence of solutions of easier-to-solve problems. For two particular classes of one-dimensional problems, the solution is developed as a sum of a sequence of solutions of equivalent isotropic scattering problems. This reduction in complexity is achieved through the introduction of an approximate scattering kernel. The particular form and properties of the approximate scattering kernel are discussed in detail for each example. The first example is the monoenergetic, one-dimensional, infinite medium, Green's function problem with an isotropic source and uniform material properties. For a deuterium scattering medium the first term of the series for the scalar flux distribution, $\Phi_0(x)$, can be made to possess an error of less than 1% for a scattering to total cross section ratio, $0 < c < 1$. In addition, the asymptotic portion of the first term of the series for the vector flux, $\psi_0(x,\mu)$, can be made equal to the asymptotic portion of the exact solution, $\psi(x,\mu)$. The second illustration of the iterative method is the monoenergetic, one-dimensional, finite slab medium problem with a uniform spatial isotropic source distribution, uniform material properties, and a vacuum boundary condition. Again, for a deuterium scattering medium with a scattering to total cross section ratio, $c = 0.900$, the first term of the series for the scalar flux can be made to possess an error of less than approximately 1% for a slab thickness of one mean free path; while an error of approximately 5% is obtainable for a slab thickness of ten mean free paths. For $0.200 \leq c \leq 0.990$ and a slab thickness of one mean free path, the error in the first term covers the approximate range from 0.1% to 1%. If this same set of finite medium problems were solved by assuming the anisotropic kernel could be replaced by an isotropic kernel, one would achieve errors ranging from 5 to 10 times greater than the errors indicated above. The sample calculations indicate that a first term of this iterative series is sufficient to obtain errors of less than 1% for a wide range of material properties and thicknesses. The error bound estimate due to truncation of the series is seen to take on the form of a geometric series. Combining this information with the error associated with the first term of the solution, one can conclude that for every additional term of the iterative series considered it may be possible to achieve approximately a factor of 0.01 decrease in the truncation error. (Dissertation Abstr.)

7683 MECHANIZED EVALUATION OF NEUTRON CROSS SECTIONS. Horsley, A.; Parker, J. B. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/24, 16p. (CONF-661014-23). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The use of mathematical splines in the mechanized evaluation of neutron cross section data is discussed. Their principal properties are the excellent approximations they give to the derivatives of a function; in contrast to conventional polynomial fitting, this feature ensures good interpolation and, when required, stable extrapolation. Various methods of using splines in data graduation and the problem of coupling these methods to standard statistical procedures are examined. The results of work done at AWRE with cubic splines on the mechanized evaluation of neutron scattering total cross-section and angular distribution data are presented. (S.F.L.)

7684 FAST NEUTRON GENERATOR. Nakai, Kiyoshi. (to Mitsubishi Atomic Power Ind., Inc.). Japanese Patent 1965-27276, Nov. 30, 1965. Filed Aug. 25, 1964.

A fast-neutron generator is proposed in which the neutron flux distribution in the axial direction of the generator can be adjusted as required. It consists, in order, of the following: the outer cylindrical body; a cylindrical body, in the wall of which is imbedded a fissile material; and an inner tube with a thermal-neutron absorbing material imbedded, in which a sample material is placed for the fast-neutron irradiation. (These cylindrical bodies and tube are arranged concentrically with some space between.) The quantity or the enrichment (or both) of an imbedded fuel-material, in the wall of the fuel cylindrical body, can be changed in the axial direction, so as to adjust as required the axial distribution of fast-neutron fluxes. (NSA of Japan)

7685 NEUTRON-GENERATING ELEMENT. Toyama, Takashi. (to Kobe Kogyo Corp.). Japanese Patent 1965-27800, Dec. 8, 1965. Filed Dec. 29, 1964.

A neutron generator is described which consists of a vacuum vessel through which T or D ions travel in a circular orbit; a device for supplying a magnetic field perpendicular to the plane of movement of the ions; an ion injector connecting to the vessel on one end for injecting positive or negative accelerated ions of T or D into the vessel; and an ion injector connecting to the other end of the vessel for injecting into the vessel the accelerated negative or positive ions of D which travel into the vessel opposed to the entering other ions from the other injector (the latter two injectors connect to the respective accelerator and the ion source in order). The accelerated ions of T or D, travelling in the vessel in a circular orbit are allowed in the vessel to impinge upon the accelerated ions of D, in the same orbit, which travel into the

vessel from the opposite direction. Neutrons are then produced by either T (d,n) ^{4}He, or D (d,n) ^{3}He reaction. (NSA of Japan)

7686 FAST NEUTRON GENERATOR. Nakai, Kiyoshi (to Mitsubishi Atomic Power Ind., Inc.). Japanese Patent 1965-27277. Nov. 30, 1965. Filed date Oct. 7, 1964.

A fast neutron generator is proposed, in which fissioning can occur uniformly throughout the fuel material (and also damage to the fuel, due to a localized irradiation can be prevented), leading to a longer life of the generator. Between the outer cylindrical body and the inner tube (in which a sample material is placed for the fast neutron irradiation) are placed a plurality of long strips with a fuel sheet imbedded, in the axial direction. These strips are arranged, one strip adjoining the other, forming as a whole a cylindrical body located between the outer cylindrical body and the inner tube. Each strip can be rotated on its axis for the uniform burning of the fuel material. (NSA of Japan)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 5747, 5986, 7520, and 7721.

7687 (ORO–1316-12) EXPERIMENTAL SITUATION IN FEW-NUCLEON SYSTEMS. Phillips, G. C. (Rice Univ., Houston, Tex. Bonner Nuclear Labs.). Aug. 1966. Contract AT(40-1)-1316. 25p. (CONF-660906–41). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Nuclear Physics, Gatlinburg, Tenn.

Recent experimental advances in measurement techniques and a catalog of data relevant to states of 2-, 3-, and 4-nucleon systems are presented. It is concluded that rapidly developing experimental techniques will allow important advances in the study of few-nucleon systems, that the simplicity of few-nucleon systems should allow a test of many-body theory and a better understanding of the mechanisms of many-particle breakup, and that these theoretical and experimental advances may be expected to yield new methods of attacking other problems of nuclear structure and spectroscopy. (S.F.L.)

7688 (USC–136-114) ANNUAL PROGRESS REPORT [ON NUCLEAR PHYSICS], OCTOBER 1, 1965–SEPTEMBER 30, 1966. (University of Southern California, Los Angeles. Dept. of Physics). Oct. 1966. Contract AT(04-3)-136. 87p. CFSTI $3.00 cy, $0.65 mn.

A DWAB analysis of the deuteron angular distribution from the reaction ^{3}He(p,d)2p was performed, and pickup reactions on ^{6}Li were studied. Angular distributions and spectra from the (p,d) (p,He-3), (p,He-4), and (p,t) reactions on ^{6}Li were measured. Similar measurements were made for the (p,He-3) and (p,He-4) reactions on ^{7}Li, and a plane-wave Born approximation was used to fit the data. A DWBA analysis of the ^{7}Li(p,d) reaction was also performed. The total reaction cross section of ^{9}Be was measured for proton energies of 16 to 28 MeV, and angular distributions for the reactions ^{8}Be (p,p), ^{9}Be(p,p'), and ^{9}Be(p,d)^{8}Be were obtained. The effect of shell closure at Z = 28 was investigated by measuring the reaction cross sections of Co, Cu, Fe, Ni, and Zn for 17-MeV protons. An optical-model analysis of proton elastic scattering by ^{9}Be was also performed. The elastic and inelastic scattering of 30-MeV protons by ^{24}Mg and ^{26}Mg was investigated; the elastic scattering data were analyzed using a diffuse-surface optical model. The elastic scattering of 28-MeV protons by nuclei around Z = 28 was investigated by measuring the angular distributions of protons elastically scattered by Co, Fe, Ni, and Zn; a good fit to the angular distribution for Zn was obtained using a diffuse-surface optical model. Cross sections for the (p,p), (p,d), and (p,t) reactions on ^{93}Nb at 30 MeV were also measured, and measurements were made of proton energy losses in a variety of materials. Variational calculations, using various types of central two-body forces compatible with N-N scattering phase shifts, were used to study the possibility of low-lying virtual excited states in the three-nucleon system. The effect of the long-range part of nuclear forces in the theory of nuclear matter was also studied, and the algebra of current components was used to study the magnetic moment of the $^3/_2^+$ decuplet and the decay modes of the hyperon (Ω^-). In addition, it was shown that the Dirac equation results from the quantization of a classical theory in which the electron is regarded as a point charge that always moves with the speed of light. (D.C.W.)

7689 EFFECT OF MOLECULAR BINDING FORCES ON THE HYDROGEN CROSS-SECTION FOR THERMAL NEUTRONS. Broecker, B. (Univ., Kiel). Atomkernenergie, 11: 423-9 (1966). (In German).

The hydrogen cross section for thermal neutrons depends on its molecular binding forces. Total neutron cross-section measurements were made on several hydrogen-containing compounds with the purpose of estimating the cross section for compounds which have not been measured, and to search for properties of molecular binding that can be determined by total neutron cross-section measurements. Starting with the general theory and some simple molecular models it is shown which physical properties of the molecule will affect the cross section. The cross sections of some compounds with characteristic properties were measured with the neutron crystal spectrometer at the FRG. The compounds are cyclohexane, benzene, paraffin, hexane, glycerin, methanol, ammonium chloride, ammonium bromide, ammonium iodide, zirconium hydride and titanium hydride. Results are given in diagrams. (auth)

7690 OPTICAL PARAMETERS FOR THE ELASTIC SCATTERING OF ^{3}He BY ^{4}He. Dunnill, F.; Gray, T. J.; Fortune, H. T.; Fletcher, N. R. (Florida State Univ., Tallahassee). Nucl. Phys., A93: 201-8(1967).

Angular distributions of the elastic scattering of ^{3}He by ^{4}He over an angular range θ_{cm} = 30 to 150° were measured for five ^{3}He bombarding energies from 12.0 to 19.0 MeV. A simple optical model with and without a spin-orbit potential was used to fit the angular distributions. In the resonance free region above 13.5-MeV bombarding energy, the optical parameters vary little from U = 100 MeV and W = 10 MeV. These values are more characteristic of alpha-particle scattering than of ^{3}He scattering. The spin-orbit potential of about 20 MeV is much larger than that found with heavier targets. (auth)

7691 PHOTONEUTRONS FROM ^{4}He. Ferrero, F.; Manfredotti, C.; Pasqualini, L.; Piragino, G.; Rama, P. G. (Univ., Turin. Instituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 45B: 273-5(Oct. 11, 1966).

The total photoneutron emission from ^{4}He was measured from the (γ,n) threshold up to 80 MeV. The integrated cross section and the absorption cross section were determined. The value obtained for the absorption cross section at about 27 MeV, taking into account the contribution of the (γ,p) reaction, indicates that a pure α–d cluster in ^{6}Li is somewhat improbable. (D.C.W.)

7692 INVESTIGATIONS OF NUCLEAR REACTIONS AT HIGH ENERGIES BY NUCLEAR RECOIL METHOD. Denisov, F. P. Tr. Fiz. Inst., Akad. Nauk SSSR, 34: 130-82(1966). (In Russian).

A brief survey is presented of literature on measurements of total cross sections of inelastic particle interactions with nuclei, angular and energy distribution of fast particles from nuclear reactions, reactions of the (p,2p) type, studies of multiply charged particles, cross sections for the formation of reaction products, and angular and energy distribution of recoil nuclei. In some cases, the data are insufficient; some erroneous results are discussed. A detailed review is given of some work concerned with obtaining data on recoil nuclei in nuclear reactions, expanding the information on photonuclear reactions and developing methods for more accurate measurements of angular and energy distribution of recoil nuclei. Detailed and accurate correlations were made of the theoretical and experimental data. 99 references. (R.V.J.)

Nuclear Properties and Reactions, 6≤ A≤ 19

Refer also to abstracts 7478, 7688, 7692, 7771, 7824, and 7847.

7693 (AD–631176) HIGH-ENERGY ELECTRON SCATTERING AS A TEST OF THE NUCLEAR CLUSTER MODEL. Griffy, T. A.; Oakes, R. J.; Schwartz, H. M. (Stanford Univ., Calif. High-Energy Physics Lab.). Mar. 1966. Contracts Nonr–225(67); AF 49(638)–1389. 19p. (HEPL–430; ITP–207). CFSTI $1.60 cy, $0.50 mn.

The possibility of using high-energy electron scattering to investigate the cluster model of light nuclei is discussed. The general formulation of the electron-cluster coincidence cross section for processes of the type A (e,e'b)B is given. Final-state interactions between the ejected cluster and the residual nucleus are taken into account using a square-well optical-model potential. Finally, the formalism is applied to the process ^{6}Li(e,e'd)^{4}He as an example. (auth)

7694 (IA–1082, pp 27-74) PHYSICS. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

A report is presented which sums up the progress made in the

research and service programs of the Soreq Nuclear Research Center during 1965. The main research topics were: elementary particle physics, nuclear physics, reactor physics, solid-state physics, and plasma physics. (B.G.D.)

7695 (USC-136-112) (p,^{3}He) AND (p,^{4}He) REACTIONS ON ISOTOPIC Li TARGETS. Forster, H. H.; Hokhikian, J.; Kim, C. C. (University of Southern California, Los Angeles). July 1966. Contract AT(04-3)-136. 8p. (CONF-660906-44). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Nuclear Physics, Gatlinburg, Tenn.

The (p,^{3}He) and (p,^{4}He) reactions on ^{6}Li and ^{7}Li targets were studied at a bombarding energy of 30.2 MeV. The particle continuum in the ^{6}Li(p,^{4}He)^{3}He and ^{7}Li(p,^{3}He)^{5}He reactions was examined for possible indications of excited states in ^{3}He and ^{5}He, respectively. Differential cross sections were measured for the ground state transitions. (auth)

7696 PHOTODISINTEGRATION OF ^{6}Li AT HIGH ENERGY. Allton, E. (Ecole Normale Superieure, Orsay, France); Ferroni, S.; Gracco, V. G.; Merkel, B.; Schaerf, C. Nuovo Cimento (10), 46A: 407-12(Nov. 21, 1966).

The differential cross section for the photodisintegration of ^{6}Li at high energy with emission of one deuteron was measured. The experimental results are roughly consistent with a theoretical model based on the impulse approximation. In this very crude model, only the coherent photoproduction of neutral pions on the virtual deuterons present in the nucleus of ^{6}Li was taken into account. (auth)

7697 NUCLEAR CROSS SECTIONS FOR CHARGED-PARTICLE-INDUCED REACTIONS. Kim, H. J.; Milner, W. T.; McGowan, F. K. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. A, 2: 1-241(Aug. 1966).

Nuclear cross sections for charged-particle-induced reactions of isotopes of C are presented in tabular and graphical form. The compilation includes experimental cross-section data available in the literature before January 1, 1964, for nuclear reactions of the type A(a,b)B at all energies, where $M_a \geq$ one nucleon mass. Nuclear reactions involving mesons in the exit channel are not included. The collection supplements a previous compilation, Los Alamos Scientific Laboratory Report LA-2014. A large amount of the cross-section data is not presented either in tabular or graphical form in order to limit the size of the compilation to a manageable one. A number of annotated bibliographies are included in the appendixes to provide a brief summary of these data. (auth)

7698 ON THE REACTION ^{19}F(p,α)^{16}O IN THE RANGE OF BOMBARDING ENERGY FROM 2.2 TO 3.4 MeV. Morita, Susumu; Nakakawa, Takemi; Hsu, Chu-chung; Lee, Sang-mu (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 21: 2435-8(Dec. 1966).

The reaction ^{19}F(p,α_0)^{16}O was studied with bombarding energies of a few MeV. Excitation curves were measured at 90 and 135° (lab) from 2.24 to 3.35 MeV with an energy step of about 20 keV. The angular distributions were measured at twelve energies in the region between 2.64 and 3.35 MeV. Most of the angular distributions are asymmetric with respect to 90° (cms). The data were analyzed with the theory of fluctuation; and the coherence energy Γ was found to be 60 keV, which corresponds to the lifetime of compound nucleus τ of 1.1×10^{-20} sec. The ratio of the direct reaction to the compound process, $\chi_D = \sigma_D/\langle\sigma\rangle$, was found to be zero at 90° (lab) and 0.90 at 135° (lab). (auth)

7699 ELASTIC AND INELASTIC SCATTERING OF DEUTERONS FROM ^{9}Be, ^{12}C, ^{14}N, AND ^{16}O AT 14 MeV. Nguyen, Dai-ca (Kyoto Univ.). J. Phys. Soc. Jap., 21: 2462-75(Dec. 1966).

Angular distributions of the elastic and inelastic scatterings of deuterons from ^{9}Be, ^{12}C, ^{14}N and ^{16}O were measured using a broad-range magnetic spectrograph with nuclear emulsion plates at intervals of 5° between 10 and 80° in the laboratory system. Deuterons leading to the 2.31-MeV, T = 1 state of ^{14}N were not distinguished from the background so that the violation of the isobaric spin selection rule was not observed. For ^{9}Be, the 2.43-MeV, $5/2^-$ rotational state was excited more strongly than the neighboring states. The 4.43-MeV rotational state of ^{12}C was also strongly excited. In the case of ^{16}O, the 6.14-MeV, 3^- octupole vibrational state was resolved from the 6.06-MeV, 0^+ state and was found to be excited more strongly than the 6.06-MeV, 0^+ state and also than the 6.92-MeV, 2^+ and 7.12-MeV, 1^- states. Comparison with the inelastic scattering data of protons and of alpha particles indicates that collective states which are excited strongly by protons and by alpha particles are also excited strongly by deuterons. Experimental angular distributions are compared with the predictions of the nuclear interaction theory of Huby and Newns and of the diffraction theory of Dar and with the results from the DWBA analysis. (auth)

7700 MASSES OF NUCLEI WITH Z > N. Kelson, I. (Yale Univ., New Haven); Garvey, G. T. Phys. Lett., 23: 689-92 (Dec. 19, 1966).

A phenomenological relation between ground-state atomic masses in conjunction with charge symmetry is used to investigate all the masses of nuclei with $A \leq 42$ with Z > N. In cases where experimental data exist the agreement with the predictions is good. (auth)

7701 PARTICLE DECAY WIDTHS OF THE DIPOLE STATES OF ^{16}O. Beres, W. P.; MacDonald, W. M. (Univ. of Maryland, College Park). Nucl. Phys., A91: 529-50(1967).

The nucleon widths for all possible decay channels of the five $J = 1^-$, T = 1 states of ^{16}O were calculated in a particle-hole basis using a theory which enables a shell-model treatment of both bound and continuum states. Separate neutron and proton wave functions are found as eigenstates of a Woods–Saxon well with spin-orbit coupling and the potential of a uniform sphere of charge. A spin-dependent residual interaction with a delta function radial dependence is used with the Soper mixture. The predicted states consist of two broad levels in the 22 and 25 MeV regions, narrow levels at 20.1 and 13.7 MeV and another level at 17.7 MeV. These levels are associated with and compared to experimental observations. The presence of the unbound $1d_{\frac{5}{2}}$ resonance in ^{17}O and ^{17}F is found to contribute significant single-particle widths to those states of ^{16}O with large $1d_{\frac{5}{2}}$ components. (auth)

7702 VIRTUAL EXCITATION OF THE 2^+ TARGET LEVEL IN NEUTRON-^{12}C ELASTIC SCATTERING. Pisent, G. (Univ., Padua); Saruis, A. M. Nucl. Phys., A91: 561-75(1967).

The n-^{12}C elastic scattering below 4 MeV was analyzed first by a single-particle model and then by a channel-coupling model which takes into account the virtual excitation of the 2^+ target level. The spherical potential is able to reproduce the behavior of the non-resonant phase shifts and the broad single-particle resonance. By considering the collective states of the target, the experimental spectrum is reproduced; and a satisfactory agreement with the experimental phase shifts is obtained. (auth)

7703 STRUCTURE OF ^{7}Be. II. THE ^{6}Li(p,p'')^{6}Li** AND ^{4}He(^{3}He,p'')^{6}Li** REACTIONS. Harrison, William D. (California Inst. of Tech., Pasadena). Nucl. Phys., A92: 260-72(1967).

The total and the differential cross sections for the ^{6}Li(p,p'') $\times$ ^{6}Li** (3.562 MeV) reaction were measured over a range of incident proton lab energies between 4.26 and 9.40 MeV. The total cross section for the ^{4}He(^{3}He,p'')^{6}Li** reaction was measured over a range of incident ^{3}He lab energies between 13.81 and 18.45 MeV. The analysis indicates the presence of two interfering states, both with $J^\pi = 3/2^-$, located at about 10.0 and 11.0 MeV excitation energy in ^{7}Be. The widths are 1.8 and 0.4 MeV, and the isospins are T = 1/2 and T = 3/2, respectively. Values for the reduced widths of the isospin allowed channels of the T = 3/2 state were extracted, and the Thomas–Ehrman shift with respect to the corresponding ^{7}Li state was estimated. The existence of an extremely broad $J^\pi = 1/2^-$ state at roughly 10 MeV or greater ^{7}Be excitation energy is suggested. Measurements were made to determine the correct normalization of several sets of data on eight ^{7}Be-forming reactions. (auth)

7704 STRUCTURE OF ^{7}Be. I. THE ^{6}Li(p,p')^{6}Li* REACTION. Harrison, William D. (California Inst. of Tech., Pasadena). Contract Nonr-220(47). Nucl. Phys., A92: 253-9(1967).

The differential cross section for the ^{6}Li(p,p')^{6}Li* (2.184 MeV) reaction was measured over a range of incident proton lab energies between 3.60 and 9.40 MeV. The analysis of a broad resonance indicates the presence of a 1.8-MeV broad state in ^{7}Be at about 10.0-MeV excitation energy with the properties $J^\pi = 3/2^-$ or $5/2^-$, with $7/2^-$ or $9/2^-$ being possible but less probable, and T = 1/2. (auth)

7705 DECAY MODES OF ^{16}O GIANT RESONANCE STATES. Owens, R. O.; Baglin, J. E. E. (Yale Univ., New Haven). Phys. Rev. Lett., 17: 1268-70(Dec. 19, 1966).

A Ge(Li) detector was used to observe de-excitation gamma rays from ^{15}N and ^{15}O following the photodisintegration of ^{16}O at giant resonance energies. Significant branching to the $(1/2^+, 3/2^+)$ states near 5 MeV implies a departure from a single-particle, single-hole E1 absorption process. (auth)

7706 CORRECTIONS OF ORDER $(1/M)^2$ TO μ-CAPTURE. Friar, James L. (Stanford Univ., Calif.). Contract AF49(638)-1389. Nucl. Phys., 87: 407-23(1966).

A Foldy–Wouthuysen reduction is made of the μ-capture Hamiltonian, keeping terms of order $(1/M)^2$. The corrections of order $(1/M)^2$ to the transition probability are then calculated for two cases, ^{16}O(0^+) $\rightarrow$ ^{16}N(0^-) and ^{12}C(0^+) $\rightarrow$ ^{12}B(1^+), which are of interest because the former provides a means of determining

the induced pseudoscalar coupling constant while the latter can be used to determine the size of the axial vector and weak magnetism coupling constants. (auth)

7707 CROSS SECTIONS FOR THE (p,n) REACTION ON ^{11}B BETWEEN 150 MeV AND 3 GeV. Sklavenitis, Laodamas (CEA, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 263: 833-6 (Oct. 3, 1966). (In French).

The results of measurements on the reaction $^{11}B(p,n)^{11}C$ at high energy are presented. The measurements performed at 155, 600, and 3000 MeV led, respectively, to the values of 3.51, 1.51, and 1.53 mbarns. The result obtained at 155 MeV coincides with L. Valentin's measurement. It is necessary to introduce corrections due to the thickness of the targets used. (tr-auth)

7708 THE $^{19}F(p,\alpha)^{16}O$ AND $^{19}F(p,^3He)^{17}O$ REACTIONS AT 30.5 MeV. Cole, Robert K. (Univ. of Southern California, Los Angeles); Dittman, Roger; Sandhu, Harbhajan S.; Waddell, Charles N.; Dickens, J. K. Contract W-7405-eng-26; AT(04-3)-136). Nucl. Phys., A91: 665-91(1967). (ORNL-P-2499).

Absolute differential cross sections for the $^{19}F(p,\alpha)^{16}O$ reaction leading to the ground state of ^{16}O, the $^{19}F(p,^3He)^{17}O$ reaction leading to the ground state of ^{17}O and the $^{19}F(p,^3He)^{17}O$ reaction leading to the first excited state of ^{17}O (E_{ex} = 0.871 MeV) were measured for angles between 7 and 155°, 16 and 111° and 16 and 111° in the cms system, respectively. The angular distributions showed strong forward peaking for all three reactions. The experimental data were compared with theoretical angular distributions obtained by distorted-wave methods. The calculated angular distributions fit the L = 0 data quite well; the L = 2 data are not so well fitted. The ratio of the experimental spectroscopic factors for the two (p,^{3}He) reactions agrees quite well with the calculated ratio. (auth)

7709 REACTION $^{14}N(n,t)^{12}C$ AT E_n = 14.4 MeV. Rendic, D. (Institute Ruder Boskovic, Zagreb). Nucl. Phys., A91: 604-8 (1967).

Triton spectra from the $^{14}N(n,t)^{12}C$ reaction at E_n = 14.4 MeV were measured by the counter telescope technique. The angular distributions of tritons for the transitions to the ground and first excited state of ^{12}C were compared with the theories of Butler and Newns. The analysis indicates that L = 2 angular momentum transfer is favored over L = 0 transfer, which is also allowed. The integrated cross section for the transition to the first excited state is larger than that to the ground state by a factor of 3.6. The plane-wave analysis indicates that the process involves a direct transfer of a n-p pair. (auth)

7710 ANGULAR DISTRIBUTIONS OF DEUTERONS FROM $^6Li(^{12}C,d)^{16}O^*$. Loebenstein, H. M.; Mingay, D. W.; Winkler, H.; Zaidins, C. S. (California Inst. of Tech., Pasadena). Nucl. Phys., A91: 481-94(1967).

The angular distributions of deuterons from the reaction $^6Li(^{12}C,d)^{16}O^*$ leading to the ground state and the first eight excited states of ^{16}O were measured at a cms energy of 7 MeV. The angular distributions of deuterons leading to the 3rd, 4th, and 5th excited states were also measured at 8 MeV, and excitation functions for these levels were taken from 6 to 8 Mev at θ_{lab} = 30 and 50°. The results were analyzed by estimating the contribution to the total cross section, due to the formation and decay of the compound nucleus in a statistical region of excitation, by means of a Hauser–Feshbach calculation. This contribution is then subtracted from the measured total cross sections, neglecting any interference effects. The difference is used to obtain reduced alpha widths for 7 levels in ^{16}O including the 7.12-MeV level which is of significance for the helium burning in stars. (auth)

7711 DWBA CALCULATIONS FOR THE REACTION $^{12}C(p,d)^{11}C$ AT 155 MeV. Towner, I. S. (Battersea Coll. of Tech., London. Nuclear Physics Lab., Oxford). Nucl. Phys., A93: 145-63(1967).

Angular distributions for the $^{12}C(p,d)^{11}C$ reaction to the ground state and three excited states of ^{11}C at a proton energy of 155 MeV were analyzed using a conventional DWBA model. Finite-range effects are treated using the local-energy approximation, and a large correction to the zero-range approximation is found for the optical potentials used. The angular distributions are relatively insensitive to the parameters of the neutron wave function. Experimental spectroscopic factors are in reasonable agreement with the theoretical predictions of intermediate coupling calculations. Possible mechanisms for transitions to "forbidden" states are considered. (auth)

7712 CROSS SECTIONS AND COMPLEX PHASE SHIFTS FOR THE SCATTERING OF PROTONS FROM ^{12}C AT THE 8.20-MeV AND 9.14-MeV ANOMALIES. Swint, J. B.; Duval, J. S. Jr.; Barnard, A. C. L.; Clegg, T. B. (Rice Univ., Houston, Tex.). Contract AT(40-1)-1316. Nucl. Phys., A93: 177-89(1967). (ORO-1316-10).

Absolute differential cross sections as a function of angle for the elastic scattering of protons from ^{12}C and for the inelastic scattering reaction $^{12}C(p,p')^{12}C^*$ (Q = −4.43 MeV) were measured at incident proton energies of 8.20 MeV and eleven energies between 9.10 and 9.26 MeV. Complex phase shifts were obtained to represent the elastic scattering cross sections and the total inelastic cross sections. The complex phase shift analysis has confirmed the $J^\pi = 3/2^-$ assignment at the 8.20 MeV anomaly and $7/2^-$ and $5/2^-$ for the stronger and weaker state at the 9.14-MeV double anomaly, respectively. These assignments were used in a calculation which reproduced the features of the elastic scattering cross sections as a function of energy over the 9.14 MeV doublet. An examination of the behavior of the phase shifts over the anomaly revealed that the total phase shift for the $f_{5/2}$ partial wave does not pass through 90°, whereas the total phase shift for the $f_{7/2}$ partial wave does pass through 90°. (auth)

7713 STUDY OF $^{10}B(d,n)^{11}C$ AND $^{11}B(d,n)^{12}C$ REACTIONS. Din, G. U. (Rice Univ., Houston, Tex.); Nagarajan, M. A.; Pollard, R. Nucl. Phys., A93: 190-200(1967).

The differential cross section at 0° for the reaction $^{10}B(d,n)^{11}C$ leaving the final nucleus ^{11}C in the ground state was measured from 3.2 to 9.0 MeV deuteron bombarding energy. The 0° excitation function is a smoothly varying function of cross section and shows no marked structure. The 0° yield curves for the reaction $^{11}B(d,n)^{12}C$ leaving the final nucleus ^{12}C in the ground and the first excited (4.433 MeV) state were measured from 1.1 to 2.9 MeV deuteron bombarding energy. The yield curves for both groups show resonance structures though at different deuteron bombarding energies. Ten angular distributions were measured for the reaction $^{10}B(d,n)^{11}C$ at 3.20, 3.75, 4.50, 5.00, 5.70, 6.30, 7.00, 7.60, 8.30, and 9.00 MeV deuteron energy. The angular distributions all show a sharp peak around 20° and a smaller contribution in the backward direction. As the deuteron bombarding energy is increased, the 20° peak becomes stronger and the cross section in the backward direction decreases. In general, the shape of the angular distribution does not change with the bombarding energy. Analyses of these angular distributions were carried out using DWBA theory. It was found that even though the angular distributions vary smoothly with energy one needs to impose an energy dependence on the deuteron and proton optical potentials. (auth)

7714 BEHAVIOUR OF THE COMPLEX PHASE SHIFTS OVER THE 5.3-MeV ANOMALY IN $^{12}C(p,p)^{12}C$. Duval, J. S. Jr.; Barnard, A. C. L.; Swint, J. B. (Rice Univ., Houston, Tex.). Contract AT(40-1)-1316. Nucl. Phys., A93: 164-76(1967). (ORO-1316-9).

The elastic scattering of protons from carbon in the neighborhood of the 5.3-MeV anomaly was investigated using a tandem Van de Graaff accelerator and a differentially pumped gas scattering chamber. Absolute differential cross sections as a function of angle were measured at thirteen energies between 5.179 and 5.480 MeV. Complex phase shifts are obtained to represent the data, and it is shown that the total phase shift for the $d_{5/2}$ partial wave does not pass through 90°. (auth)

7715 MEASUREMENTS OF CROSS SECTIONS FOR (n,2n), (n,p), AND (n,α) REACTIONS AT 14.7 MeV. Pasquarelli, A. (Poletecnico, Turin). Nucl. Phys., A93: 218-22(1967).

Measurements of some cross sections for (n,2n), (n,p), and (n,α) reactions induced by 14.7-MeV neutrons in N, F, Na, Mg, Si, P, S, Cl, and K are described. The technique employed was that of detecting the induced β activity in the target material. To check the absolute values of the cross sections, the cross section for the reaction $^{63}Cu(n,2n)^{62}Cu$ was measured to be 511 ± 15 mb, in good agreement with the values obtained elsewhere. (auth)

7716 RADIATIVE CAPTURE BY ^{19}F: THE GIANT DIPOLE RESONANCES IN ^{20}Ne. Segel, R. E.; Vager, Z.; Meyer-Schuetzmeister, L.; Singh, P. P.; Allas, R. G. (Argonne National Lab., Ill.). Nucl. Phys., A93: 31-48(1967).

The radiative capture of protons by ^{19}F was studied over the range of proton bombarding energies from 2.88 to 12.80 MeV. The most intense capture gamma rays are γ_0 to the ground state and γ_1 to the first excited state in ^{20}Ne. The yield curves for both γ_0 and γ_1 are dominated by the E1 giant resonance with the γ_1 giant resonance displaced upward in excitation energy from the γ_0 giant resonance. Strong, well correlated structure is present in the yield curves; the structure has a characteristic width of about 175 keV. Extensive angular-distribution measurements showed that the angular distributions do not vary greatly with energy. The angular distributions are incompatible with γ_0 and γ_1 emanating from the same levels of the compound nucleus. The integrated yields, structure, and angular distributions are compared with the results of other (p,γ) studies of the E1 giant resonance, and some of the features of this and other radiative-

capture experiments are discussed in terms of the shell model. (auth)

7717 EXPERIMENTAL STUDY OF THE SPECTRUM SHAPE FOR THE GAMOW–TELLER TRANSITION $^{14}O \rightarrow {}^{14}N$. Sidhu, Gurnam Singh. Seattle, Univ. of Washington, 1966. 185p.

Thesis.

The shape of the positron spectrum of the Gamow–Teller transition $^{14}O \rightarrow {}^{14}N$ was measured in the energy range beyond the 1.8-MeV end-point of the positrons from the Fermi transition $^{14}O \rightarrow {}^{14}N^*$. ^{14}O ($t_{\frac{1}{2}} = 71$ sec) was produced by the $^{14}N(p,n)^{14}O$ reaction and was swept continuously to the source position of a beta spectrometer where it was frozen on a source holder in the form of $H_2{}^{14}O$. An iron-free solenoid-field beta spectrometer was used for the measurement of the positron spectrum. The ^{14}O source activity was monitored by counting 2.31 MeV gamma rays from $^{14}N^*$ following the positrons of the $^{14}O \rightarrow {}^{14}N^*$ (Fermi) branch. The observed shape factor of the 4.1-MeV end-point Gamow–Teller transition, in the range 2 to 4 MeV, was found to have an energy dependence of $-9.38 \pm 0.44\%$ per MeV, after eliminating theoretical contributions of the small forbidden terms other than the interference term of the allowed and $(\vec{\alpha} \times \vec{r})$ nuclear matrix elements. This energy dependence is larger than any observed previously for allowed transitions. It is in good agreement with predictions based on the nuclear wave functions calculated by Visscher and Ferrell. The ft value and the branching fraction for this transition were measured to be $2.10 \pm 0.03 \times 10^7$ sec and $0.62 \pm 0.01\%$, respectively. The allowed nuclear matrix element $\langle\sigma^+\rangle$ (defined $\sigma^+ = \sigma_1 + i\sigma_2/2$) calculated using this ft value is $+5.62 \pm 0.14 \times 10^{-3}$. Its sign was determined from the observed shape factor. The largest forbidden term in the interaction Hamiltonian, mainly responsible for the deviation of the Kurie plot from linearity, is $\vec{\alpha} \times \vec{r}$. Its nuclear matrix element (leading to $m_J = +1$ state) was determined from the shape factor to be $0.625 \pm 0.032\ \hbar/M_pc$. According to the conserved vector current theory of weak interactions, the measured value of this forbidden matrix element can be used to calculate the lifetime of the analogous M1 gamma transition $^{14}N^* \rightarrow {}^{14}N$. The half life of $^{14}N^*$ determined by this means is $2.27 \pm 0.23 \times 10^{-14}$ sec, in agreement with theoretical predictions. This differs from the value $5.1 \pm 1.3 \times 10^{-14}$ sec, obtained by Swann et al., by measuring the resonant scattering cross-section for 2.31-MeV gamma rays on ^{14}N. (Dissertation Abstr.)

7718 (p,n) AND (p,2n) CROSS SECTIONS OF NINE ELEMENTS FROM 7 TO 15 MeV. Yates, Michael Kenneth. Berkeley, Calif., Univ. of California, 1966. 72p.

Thesis.

Some (p,n) and (p,2n) excitation functions were measured for thin targets of Al, Ti, V, Co, Zr, Nb, Ag, Ta, and Au with 7 to 15 MeV protons. The emitted neutrons were detected by a large gadolinium-loaded liquid scintillator detector, and the two competing processes were separated by statistical analysis. Also, thin target neutron yield cross sections were measured, and level density parameters were calculated. (Dissertation Abstr.)

7719 STUDY OF THE $^9Be(n,2n)$ REACTION AT 14 MeV. Bouchez, R.; Gondrand, J. C.; Perrin, P.; Perrin, C.; Giorni, A.; Darves-Blanc, R.; Quivy, P. (CEN, Grenoble, France. Univ., Grenoble, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/76, 8p. (In French). (CONF-661014-12). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The $^9Be(n,2n)$ reaction was studied using double time-of-flight spectrometry and was found to take place mainly through the formation of ^9Be resonance states (6.76 and 7.94 MeV). The contribution of the direct process $^9Be + n_1 + n_2$ is small in spite of the weak binding (1.66 MeV) of the peripheral neutron $p_{\frac{1}{2}}$ in ^9Be, compared with the incident energy $E_n = 14.5$ MeV. Measurements made at $\varphi_1 = -\varphi_2 = 30°$, 60°, 80° and at $\varphi_1 = 30°$, $\varphi_2 = -15°$ show anisotropy of the (n,2n) reaction, predominantly towards the forward angles. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 7458, 7688, 7692, 7716, 7771, 7777, 7794, 7801, and 7824.

7720 (AECD-EP-15) MEASUREMENT OF TOTAL NEUTRON CROSS-SECTION. Ahmed, Motaheruddin; Ahsan, Mohammad; Ali, Saqeba; Hussain, Muhtasham (Atomic Energy Centre, Dacca (Pakistan)). July 1966. 9p. Dep. mn.

The neutron total cross section of ^{27}Al was measured by the transmission method for neutrons of 0.756-MeV energy. The source of neutrons was a target of tritium diffused in titanium ($0.25\ g/cm^2$) with gold backing which was bombarded with 1.83-MeV protons from a Van de Graaff accelerator. The experiment was performed to standardize a technique to be used in total cross section measurements for a number of elements in the energy range 0.1 to 18 MeV. (S.F.L.)

7721 (AECL-2611) PHYSICS DIVISION PROGRESS REPORT, APRIL 1, 1966–JUNE 30, 1966. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 75p. (PR–P–70). Dep. mn. AECL $2.00.

Progress is reported on studies of anisotropy of fission fragments in the $^{235}U(d,pf)$ and $^{239}Pu(d,pf)$ reactions; gamma ray angular correlation measurements on levels in ^{29}Si; ^{20}Ne levels populated by the $^4He(^{16}O,\gamma)$ reaction; lifetimes of levels in ^{24}Mg; gamma-ray branching ratios of low-lying levels of ^{29}Si; gamma transition energies in ^{125}I and ^{143}Pr; measurement of the 2200 m/sec neutron cross section for deuterium relative to that of ^{59}Co; measurement of the half life of ^3H; inelastic neutron scattering from phonons in potassium at 299°K; measurements of the [ξξξ] L branch of the phonon spectrum in the alloy $Nb_{0.25}-Mo_{0.75}$ at room temperature using coherent one-phonon scattering of slow neutrons; crystal dynamics of tin telluride; magnetic excitations in CoF_2 crystals below a frequency of 5×10^{12} cps at 90 and 5°K by means of inelastic neutron scattering; gamma energies from the $^{50}Cr(n,\gamma)^{51}Cr$ reaction for thermal neutrons; and effects of space and image charges in a bunched ion beam. (S.F.L.)

7722 (AEET-254) VAN DE GRAAFF LABORATORY PROGRESS REPORT. David, T. P. (comp.) (Atomic Energy Establishment, Trombay (India)). 1966. 69p. Dep. mn.

Improvements were made to the Van de Graaff accelerator. A transistorized variable-current power supply was developed, and a probe for NMR measurements was constructed. The differential cross section of the $^{40}Ca(He-3,p)^{42}Sc$ reaction was calculated using a modified zero-range approximation in the distorted-wave formalism. The spins of the first two excited states of ^{27}Mg were determined by p-γ angular correlation measurements in the reaction $^{26}Mg(d,p\gamma)^{27}Mg$. The energy levels of ^{10}B were investigated using alpha elastic scattering by ^6Li. Fluctuation theory was applied to the cross sections of the reactions $^{27}Al(p,\alpha)^{24}Mg$ and $^{27}Al(p,p_3)$. The mechanism of the $^{51}V(p,n\gamma)$ reaction was investigated by measuring n–γ correlations and the excitation functions of the gamma rays. The integrated cross sections of (α,n) and (p,n) reactions were also studied. Excitation functions for alpha elastic scattering by ^{24}Mg at 3.44 to 5.50 MeV were measured; ten resonances corresponding to levels in ^{28}Si were observed. The energy levels of ^{27}Al were investigated using proton reactions (p,α) and proton scattering. The angular distribution of the reaction $^{19}F(n,\alpha)^{16}O$ at 4.7 MeV was also measured, as were excitation functions for proton elastic scattering by ^{12}C, ^{16}O, and ^{51}V and for the reaction $^{51}V(p,n)$. A two-parameter analyzing facility for coincidence experiments on nuclear reactions was developed, and a getter-ion pump was built and tested. Two computer programs were written in Fortran for fluctuation analysis of cross sections. (D.C.W.)

7723 (BNWL-SA-315) GAMMA-RAY TRANSITIONS IN ^{58}Fe. Hill, M. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. Brigham Young Univ., Provo, Utah). Sept. 14, 1965. Contract AT(45-1)-1830. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The energies and intensities of the γ-ray transitions in ^{58}Fe following the decay of ^{58}Co were measured using Li-drifted Ge detectors. The values obtained were 810.5 ± 0.3 keV (99.3%), 863.0 ± 0.3 keV ($0.77 \pm 0.04\%$), and 1674.1 ± 1.0 keV ($0.68 \pm 0.05\%$). The value given for the intensity of the 863 keV transition differs considerably from previously reported values. (S.F.L.)

7724 ISOMER PAIR CROSS SECTIONS BY 13.4 TO 15.0 MeV NEUTRONS. Okumura, Shoji (Kyoto Univ.). Nucl. Phys., A93: 74-80(1967).

The cross sections of $^{58}Ni(n,p)^{58m,g}Co$, $^{59}Co(n,2n)^{58m,g}Co$, $^{75}As(n,p)^{75m,g}Ge$, $^{76}Ge(n,2n)^{75m,g}Ge$, and $^{81}Br(n,2n)^{80m,g}Br$ were measured by an activation method for neutron energies from 13.39 to 14.96 MeV. The experimental isomer ratios are almost constant over this energy region. They were analysed on the basis of the statistical theory. The cross sections of $^{79}Br(n,2n)^{78}Br$ were also obtained for the same energy range. (auth)

7725 STUDIES ON NUCLEAR STRUCTURE IN THE 2s-1d SHELL. III. GROUP THEORY AND PARTICLE-HOLE STATES Flores, J.; Moshinsky, M. (Univ., Mexico). Nucl. Phys., A93: 81-109(1967).

The methods of group theory employed in previous articles of this series for particles in the 2s-1d shell are generalized to particles in the 2s-1d and holes in the 1p shell still considering that all single-particle states correspond to an harmonic oscillator common potential. Polynomials in creation operators for the particles and annihilation operators for the holes which are char-

acterized by irreducible representation (IR) of a chain of groups are constructed. These IR will now have both positive and negative indices. The techniques for constructing the polynomials belonging to these IR are explicitly developed for all the groups in the chain. These polynomials are then applied to a physical vacuum state corresponding to an empty 2s-1d and filled 1p shells. As the physical vacuum state is not characterized by a scalar IR for all the groups in the chain, the application of the polynomials to it raises a problem of reduction of Kronecker products of IR of the groups in question which is explicitly solved. From the set of states the spurious states due to cms motion are eliminated. It is then proved that for the remaining states the model interaction introduced previously takes care appropriately of the short-range, long-range, and spin-orbit coupling correlations. With the help of the model interaction, some examples are discussed, in particular the negative-parity states of ^{18}O and ^{18}F. (auth)

7726 EFFECT OF DEFORMED STATES IN THE Ca ISOTOPES. Gerace, W. J. (Princeton Univ., N. J.); Green, A. M. Contract AT(30-1)-937. Nucl. Phys., A93: 110-32(1967). (PUC-937-213).

An attempt is made to explain the low-lying levels of ^{40}Ca, ^{41}Ca, ^{42}Ca, and ^{41}Sc as mixtures of shell-model and deformed states. The deformed states are constructed using the isospin-coupling scheme of Zamick, and the matrix elements between spherical and deformed states are calculated using the Hamada-Johnston nucleon-nucleon force. Wave functions are obtained for these states, and predicted values for some transition rates and single-particle strengths are compared with experiment. (auth)

7727 DIFFRACTION EFFECTS IN PROTON TRANSFER REACTIONS. Wilczynski, J.; Volkov, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., A93: 133-44(1967).

A study of transfer reactions with heavy ions was undertaken to provide information concerning diffraction effects. The proton pick-up reactions $^{27}Al(^{12}C,^{13}N)^{26}Mg$ and $^{12}C(^{12}C,^{13}N)^{11}B$ were investigated. Energy and angular distributions of the ^{13}N reaction products were measured at different energies of the ^{12}C ions. The angular distributions exhibit diffraction oscillations which damp out with decreasing bombarding energy. The experimental data are compared with predictions of the Frahn and Venter diffraction model and with the theoretical results of Gareyev, Grabowski, and Kalinkin. (auth)

7728 INVESTIGATIONS OF THE LOW-LYING STATES IN ^{70}Ge AND ^{72}Ge. Kregar, M.; Elbek, B. (Univ. of Copenhagen) Nucl. Phys., A93: 49-62(1967).

The low-lying states in ^{70}Ge and ^{72}Ge were excited by scattering of 12-MeV deuterons. The angular distributions of the deuterons elastically and inelastically scattered by states up to 2.6 MeV were measured by means of a dE/dx solid-state detector system. The 1.71-MeV and 2.16-MeV levels in ^{70}Ge were assigned as 2^{+} and 4^{+} on the basis of the angular distributions, which were similar to those of the corresponding levels in ^{72}Ge. In both isotopes, a strongly excited level at about 2.5 MeV was assigned as 3^{-} on the basis of systematics. A DWBA analysis was performed for the elastic scattering and for the inelastic scattering to the 2^{+} and 3^{-} levels. Double Coulomb excitation by means of 30 to 37.5 MeV ^{16}O ions was used to excite the 0^{+} level in both isotopes. The reduced transition probabilities $B(E2,2^{+} \rightarrow 0^{+})$ were found to be <40 fm^4e^2 and 51 ± 5 fm^4e^2 for ^{70}Ge and ^{72}Ge, respectively. (auth)

7729 THE (n,d) REACTION ON Cu AND Zn ISOTOPES. Chursin, G.; Fazio, M.; Micheletti, S.; Pignanelli, M.; Zetta, L. (Univ., Milan. Istituto Nazionale di Fisica Nucleare-Sezione, Milan). Nucl. Phys., A93: 209-17(1967).

Deuteron energy spectra and angular distributions from the (n,d) reaction initiated by 14-MeV neutrons on the isotopes ^{65}Cu, ^{66}Zn, and ^{68}Zn are given. The angular distributions are fitted with the DWBA, and the results are interpreted in terms of the Cu isotope structure as predicted by the unified model. (auth)

7730 THE CONFIGURATIONAL SPLITTING OF THE DIPOLE GIANT RESONANCE FOR THE NON-MAGIC NUCLEI OF THE 1d-2s SHELL AS DEMONSTRATED BY ^{32}S. Goryachev, B. I.; Majling, L.; Neudatchin, V. G.; Yurev, B. A. (Moscow State Univ.). Nucl. Phys., A93: 232-40(1967).

It was shown by specific calculations for the ^{32}S nucleus that the configurational splitting of the giant resonance is conserved even after the residual interaction is taken into account. The results for the following two cases are compared: ^{32}S nucleus as a closed sub-shell $1d_{\frac{5}{2}} + 2s_{\frac{1}{2}}$ and as a soft core distorted, in particular, under the influence of the quadrupole vibrations. The most general features of the dipole absorption curve are comparatively stable with respect to the perturbation of the wave function of the ground state, and yet the details of this curve are substantially different. The results of the calculations reproduce correctly the characteristic features of the absorption curve, in particular, a very considerable width of the absorption region. The excitation of the left part of the absorption curve in the reaction (p,γ_0) and the two maxima in the elastic scattering cross section are explained. (auth)

7731 GAMMA TRANSITIONS IN ^{63}Cu. Holmberg, P.; Spring, E.; Lundan, A. (Univ. of Helsinki). Soc. Sci. Fenn., Comment. Phys.-Math., 32: No. 12, 1-6(1966).

The energies and relative intensities of gamma rays from the $T_{\frac{1}{2}}$ = 38 min decay of ^{63}Zn produced in the (n,2n) reaction on natural Zn were measured. A decay scheme is proposed for ^{63}Cu, and it is concluded that the lowest-lying levels in ^{63}Cu are fed by both β^{+} decay and electron capture. Branching ratios are given for the decay of ^{63}Zn. (D.C.W.)

7732 STANDARDIZATION OF A ^{54}Mn SOLUTION BY 4πX, e(PC)-γ COINCIDENCE COUNTING: A SIMPLE METHOD OF EVALUATING THE DECAY SCHEME CORRECTION. Granados, C. E.; Rytz, A. (Bureau International des Poids et Mesures, Sevres, France). Metrologia, 2: 90-2(Apr. 1966).

A method is described for determining the decay-scheme correction which is applicable to radionuclides decaying by electron capture followed by γ emission. The technique was developed in connection with an international comparison of a ^{54}Mn solution which was contaminated accidentally by 1.8% of ^{35}S before it was distributed. A formula is given which includes a contamination term and expresses the count rates observed in a conventional 4π (PC)-γ counting system, corrected for background, dead times, and accidental coincidences. (S.F.L.)

7733 ATTEMPT TO OBSERVE THE DIRECTIONAL CORRELATION OF THE 1700 TO 1077 keV GAMMA-RAY CASCADE IN ^{68}Zn. Taylor, H. W. (Univ. of Alberta, Edmonton). Nucl. Phys., A91: 659-64(1967).

Directional correlation measurements were made on the 1700 to 1077 keV gamma cascade in ^{68}Zn using a scintillation coincidence spectrometer. Correlations were observed using different thicknesses of absorber in front of the counters in order to attenuate the effects of annihilation radiation on the correlation. The correlation in each case was expressed in the form $W(\theta) = 1 + A_2P_2(\cos\theta) + A_4P_4(\cos\theta)$. The variations of A_2 and A_4 with absorber thickness and arguments based on beta-decay theory suggest that the spin sequence 2(1,2) 2(2)0 is appropriate for the cascade. The spin and parity 2^{+} is tentatively assigned to a 2780 ± 18 keV level in ^{68}Zn. (auth)

7734 INTERNAL CONVERSION COEFFICIENTS IN THE DECAY OF ^{57}Co. Hall, D. C.; Albridge, R. G. (Vanderbilt Univ., Nashville). Nucl. Phys., A91: 495-504(1967).

The K and total conversion coefficients in the decay of ^{57}Co were measured to be $\alpha_K(136) = 0.122 \pm 0.013$, $\alpha_T(136) = 0.137 \pm 0.015$, $\alpha_K(122) = 0.0214 \pm 0.0012$, $\alpha_T(122) = 0.0240 \pm 0.0014$, $\alpha_K(14) = 9.1 \pm 0.8$, $\alpha_T(14) = 10.2 \pm 0.9$. All published values of conversion coefficients of the 14-keV transition are summarized and weighted averages computed. The conversion coefficients of all three transitions are used to determine transition multipolarities. It is determined that 87.0 ± 1.5% of the transitions depopulating the 136-keV level are 122-keV transitions. (auth)

7735 THE K-AUGER SPECTRUM OF ARSENIC. Johnston, R. E.; Douglas, J. H.; Albridge, R. G. (Vanderbilt Univ., Nashville). Contract AT(40-1)-2401. Nucl. Phys., A91: 505-12 (1967).

The relative intensities and energies of the KLL-Auger transitions of ^{75}As (Z = 33) were measured by means of an iron-free, double-focusing β spectrometer. The measured energies agree well with those calculated semi-theoretically by Hörnfeldt. A graphical summary of KLL Auger relative intensities is presented. It compares the experimental values (including those of this work) to some of the most recent theoretical values. The ratio of the KLM to the KLL intensity was measured to be 0.24 ± 0.04. (auth)

7736 SPINS OF THE FIRST AND SECOND EXCITED STATE OF ^{53}Mn. Vuister, P. H. (Utrecht Rijksuniversiteit). Nucl. Phys., A91: 521-8(1967).

The $^{52}Cr(p,\gamma)^{53}Mn$ resonances at 1724, 1788, and 2149 keV were investigated. Gamma-gamma angular correlation and gamma polarization measurements are described. The ^{53}Mn levels at 0.38 and 1.29 MeV, and the 1788- and 2149-keV resonances have J^{π} = $\frac{5}{2}(^{-})$, $\frac{3}{2}^{-}$, $\frac{1}{2}$, and $\frac{5}{2}$, respectively. The multipole mixing ratio of the 0.38-MeV gamma transition is −0.61 ± 0.08. (auth)

7737 LIFETIMES OF THE 1.10- AND 1.29-MeV EXCITED STATES IN ^{59}Co. Sidhu, N. P. S.; Gupta, U. C. (Atomic Energy Establishment, Trombay, India). Nucl. Phys., A91: 557-60 (1967).

The half lives of the 1.10- and 1.29-MeV excited states in ^{55}Co produced by the beta decay of ^{55}Fe were measured by the fast-slow delayed coincidence method. The values obtained are ≦ 0.05 and 0.60 ± 0.05 nsec, respectively. (auth)

7738 INVESTIGATION OF STATES OF ^{39}Ar BY THE ^{38}Ar(d,p)^{39}Ar REACTION. Holbrow, C. H.; Rosner, B. (Univ. of Pennsylvania, University Park). Nucl. Phys., A91: 551-6 (1967).

Argon gas enriched to 20% in ^{38}Ar was bombarded with 11-MeV deuterons. Outgoing protons were magnetically analyzed and recorded on nuclear emulsions. Five proton groups corresponding to states in ^{39}Ar at 0, 1.262, 2.630, 3.258, and 4.377 MeV excitation were observed, and their angular distributions were measured. Using distorted-wave calculations, l-values and spectroscopic factors were determined. The ground state was excited by an l = 3 transition and the other four states were excited by l = 1 transitions. Spin and parity assignments and the location of neutron single-particle states are discussed. (auth)

7739 STUDY OF MEDIUM-MASS NUCLEI BY INELASTIC SCATTERING OF 155-MeV PROTONS. II. INELASTIC SCATTERING BY SOME $f_{\frac{7}{2}}$ NUCLEI (^{48}Ti, ^{52}Cr, ^{56}Fe, ^{51}V, AND ^{59}Co). Ricci, R. A.; Jacmart, J. C.; Liu, M.; Riou, M.; Ruhla, C. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys., A91: 609-32(1967). (In French).

The differential cross sections from 8 to 40° of 155-MeV protons on some $f_{\frac{7}{2}}$ nuclei (^{48}Ti, ^{52}Cr, ^{56}Fe, ^{51}V, and ^{59}Co) were measured. Quadrupole excitations in even $f_{\frac{7}{2}}$ nuclei were found with a more pronounced collective behavior for N ≠ 28 nuclei. The properties of the first 2^+ levels show typical shell effects at N = 28. Octupole excitations were also established, which do not show strong shell effects, and are distributed among different levels; a good agreement is found with the location of particle-hole states belonging to the $(f_{\frac{7}{2}})(d_{\frac{3}{2}})^{-1}$ and $(f_{\frac{7}{2}})(2s_{\frac{1}{2}})^{-1}$ configurations as predicted by (p,2p) experiments. Concerning the ^{51}V and ^{59}Co odd nuclei, strong E2 and E3 transitions, which seem to be connected with core excitations, were observed. Moreover, the results seem to establish the presence of E3 excitations corresponding to the $(2s_{\frac{1}{2}})^{-1}$ single-hole states determined by (p,2p) experiments. (auth)

7740 THE ^{28}Si(^{3}He,^{4}He)^{27}Si REACTION. Wildenthal, B. H.; Glaudemans, P. W. M. (Rice Univ., Houston, Tex.). Nucl. Phys., A92: 353-64(1967). (ORO-1316-11).

The angular distributions of the ^{28}Si(^{3}He,^{3}He)^{28}Si and ^{28}Si(^{3}He,^{4}He)^{27}Si reactions were measured at $E_{^3He}$ = 10 MeV for lab angles between 15 and 165°. The analysis of the elastic scattering with the optical model and the analysis of the (^{3}He,^{4}He) angular distributions with the DWBA theory indicate that these reactions are mainly direct in nature. The l_n values of the extracted neutrons are found to be 2, 0, 2, and 2 for, respectively, the ground state and the first, second, and fourth excited states of ^{27}Si. The data for the third excited state give no evidence of a pickup mechanism. The excitation functions of the (^{3}He,^{4}He) reaction from 8 to 10.5 MeV bombarding energy show significant structure. Thus, it appears that the detailed features of individual angular distributions may be distorted by interference of the predominant direct-reaction mode with non-direct mechanisms. Within the limitations discussed in the text, spectroscopic factors of 2.0, 0.7, 0.5, and 1.3 were assigned to the ground state and the 0.78-, 0.96-, and 2.65-MeV excited states, respectively. (auth)

7741 $\frac{3}{2}^-$ GROUND STATE OF ^{47}V. Rosner, B.; Pullen, D. J. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 18: 13-14(Jan. 2, 1967).

The low-lying levels of ^{47}V were investigated using the ^{46}Ti(He_3,d)^{47}V reaction at 16.5 MeV. Deuteron angular distributions and spectra were measured. Assignments of $\frac{3}{2}^-$, $\frac{5}{2}^-$, and $\frac{7}{2}^-$ were indicated for the ground, 0.089-MeV, and 0.147-MeV states, respectively. The levels at 1.664 and 0.258 MeV were identified as $\frac{1}{2}^+$ and $\frac{3}{2}^+$ hole states, respectively. (D.C.W.)

7742 T-FORBIDDEN EXCITATION OF ISOBARIC ANALOGUE STATES IN THE ^{37}Cl(p,α_0)^{34}S REACTION. Bosnjakovic, B.; van der Leun, C. (Rijksuniversiteit, Utrecht). Phys. Lett., 23: 687-9(Dec. 19, 1966).

The analogues of the two lowest levels of ^{38}Cl, with $J^\pi = 3^-$ and 5^-, were excited in the T-forbidden reaction ^{37}Cl(p,α_0)^{34}S. The $J^\pi = 3^-$ analogue state is split into several components which form a micro-giant resonance. (auth)

7743 STUDY OF ^{27}Al BY ELASTIC ELECTRON SCATTERING. Stovall, T.; Vinciguerra, D.; Bernheim, M. (Ecole Normale Superieure, Orsay, France). Nucl. Phys., A91: 513-20(1967).

The elastic scattering of 80 to 200 MeV electrons on ^{27}Al is studied. Measurements at 180° show that the experimental magnetic cross section is smaller than the theoretical predictions. The analysis of the electric scattering gives a value a = 2.98 fm for the root mean square radius and a value Q = 14.6 fm^2 for the nuclear quadrupole moment. (auth)

7744 FORMATION OF ^{7}Be IN NUCLEAR REACTIONS INDUCED BY 85-MeV PROTONS. Lafleur, M. S.; Porile, N. T.; Yaffe, L. (McGill Univ., Montreal). Can. J. Chem., 44: 2749-67(Nov. 15, 1966).

Cross sections were measured for the formation of ^{7}Be in targets bombarded with 85-MeV protons. The variation of these cross sections with the mass and neutron-to-proton ratio of the target was investigated. Cross-section calculations were performed on the assumption that ^{7}Be is emitted from the irradiated target as an evaporated particle. Calculated and measured cross sections were in good agreement for medium and heavy targets (A > 55). The calculation underestimated the production of ^{7}Be in light targets (27 < A < 55). (auth)

7745 THE ANOMALOUS DIP IN TOTAL REACTION CROSS SECTIONS IN THE NICKEL REGION. Dicello, J. F.; Igo, G.; Roush, M. L. (Los Alamos Scientific Lab., N. Mex.). Phys. Lett., 23: 685-7(Dec. 19, 1966).

A dip in reaction cross sections for protons, deuterons, and alpha particles was observed previously in the vicinity of nickel. The present measurements on separated isotopes in the nickel region for 14.5-MeV protons reveal that the dip is associated with the relatively low average value of N for nickel. (auth)

7746 INTERMEDIATE STRUCTURE IN THE ^{59}Co NEUTRON TOTAL CROSS SECTION BETWEEN 0 AND 500 keV. de Barros, S.; Chevillon, P. L.; Huynh, V. D.; Jackson, H. E.; Julien, J.; Morgenstern, J.; Samour, C. (Centre d'Etudes Nucleaire, Saclay, Gif-sur-Yvette, France). Phys. Lett., 23: 683-5(Dec. 19, 1966).

The neutron strength function of cobalt was measured for neutron energies between 0 and 500 keV. Intermediate structure in the form of oscillators with widths of about 40 keV is observed. (auth)

7747 TOTAL NEUTRON CROSS SECTIONS OF ISOTOPES AND THE ISOBARIC SPIN TERM OF THE NUCLEAR POTENTIAL. Dukarevich, Yu. V.; Dyumin, A. N.; Kaminker, D. M. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Phys., A92: 433-48(1967).

Total neutron cross sections were measured for the isotopes of Ni, Zn, Ag, Cd, In, Sn, Sb, and Te at a neutron energy of 14.2 MeV. An optical-model analysis shows that in order to explain the relations revealed in the shape of the cross-section curve, it is necessary to introduce a dependence of the depth of the real and imaginary parts of the potential on the nuclear asymmetry parameter $\alpha = (N - Z)/A$. The values of the real and imaginary parts of the isobaric spin term of the potential obtained in the surface absorption model are $V_1 = -17 \pm 2$ MeV and $W_1 = -26 \pm 9$ MeV, respectively. On the basis of the optical-model analysis it is concluded that the volume absorption is important at the energies considered. (auth)

7748 A STUDY OF THE (t,p) REACTIONS LEADING TO ^{48}Ti AND ^{50}Ti. Hinds, S.; Middleton, R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Phys., A92: 422-32 (1967).

Angular distributions of the proton groups from the ^{46}Ti(t,p) and ^{48}Ti(t,p) reactions were measured at incident triton energies of 9.64 and 11.14 MeV, respectively, using a multiangle magnetic spectrograph. Nine distributions of the stronger groups from the ^{46}Ti(t,p) reaction were measured leading to states of ^{48}Ti up to an excitation of 5.50 MeV. For the ^{48}Ti(t,p) reaction distributions of 24 stronger groups were measured up to an excitation of 8.29 MeV in ^{50}Ti. The results were analyzed using plane-wave, two-nucleon stripping theory and many L-value assignments were made. The results are compared with the corresponding (d,p) reactions, and in all cases where comparisons may be made the l_n values from the latter agree with the (t,p) L-values. For both (t,p) reactions the ground-state groups are strong and are formed by L = 0, two-neutron transfer. The low-lying excited states are very weak in both reactions but strong L = 0 transitions were observed to the 4.97-MeV excited state of ^{48}Ti and to the 3.88-MeV state of ^{50}Ti. Neither of these states is appreciably excited in the corresponding (d,p) reaction. A discussion on the possible structure of these states and the occurrence of similar states in neighboring nuclei was reported previously. (auth)

7749 A STUDY OF (^{3}He,n) REACTIONS ON ^{24}Mg, ^{28}Si, AND ^{32}S. McMurray, W. R.; van der Merwe, P.; van Heerden, I. J. (Southern Universities Nuclear Inst., Faure, S. Africa). Nucl. Phys., A92: 401-21(1967).

Using a time-of-flight spectrometer, measurements were made on the neutron groups from the ^{24}Mg(^{3}He,n)^{26}Si reaction at 4.9, 5.2, and 5.6 MeV; the ^{28}Si(^{3}He, n)^{30}S reaction at 5.14 and 5.6 MeV; and

the $^{32}S(^3He,n)^{34}Ar$ reaction at 5.6 MeV. The ground-state Q-values for the reactions were measured to be +75 ± 30, –579 ± 25, and –760 ± 30 keV, respectively. Groups were measured corresponding to levels at 2.78, 3.35, (3.77), 3.89, and 4.16, all ±0.04 MeV in ^{26}Si, 2.21, 3.43, and 3.71, all ±0.03 MeV in ^{30}S, and at 2.19 ± 0.04 and 3.59 ± 0.06 MeV in ^{34}Ar. There is a close correspondence between some of the previously unreported levels and analogous states in the A = 26, 30, and 34 isobaric triplets. Angular distributions and absolute cross sections were measured for several neutron groups from these reactions. The results show that the reaction is predominantly a direct one at these energies. Plane wave and distorted wave double stripping calculations give reasonable fits in the forward direction particularly for L = 0 transitions. Simple double stripping theory does not explain the relatively large cross sections at backward angles observed for some transitions. (auth)

7750 TWO-PARTICLE STATES EXCITED BY (α,d) REACTIONS ON s-d SHELL NUCLEI. Kim, Dong-hyok (Kyoto Univ.). J. Phys. Soc. Jap., 21: 2445-61(Dec. 1966).

The (α,d) reactions in ^{24}Mg, ^{28}Si, ^{32}S and ^{40}Ca were studied using 29.0-MeV alpha particles. The energy spectra of deuterons obtained were dominated by two or more strongly excited levels. Levels at 2.73, 3.64, 4.06 and 4.79 MeV of ^{34}Cl are identified to be 2^-, 5^-, 3^- and 4^- states, respectively, which arise from a $d_{3/2}f_{7/2}$ configuration, by the use of the relation between the particle-particle and the particle-hole interaction energies, which is given by the shell theory. Levels at 3.60 MeV of ^{26}Al and 4.17 MeV of ^{30}P are identified to have the same $d_{3/2}f_{7/2}$, j = 5 configuration as the 3.64-MeV level of ^{34}Cl from their large spectroscopic amplitude, the similarity of their angular distribution, and the relation between their reaction Q values and the mass number of the residual nuclei. Levels at 7.11 MeV of ^{30}P, 5.23 MeV of ^{34}Cl, and 0.60 MeV of ^{42}Sc are identified to have a $f_{7/2}$, j = 7 configuration for the reasons mentioned above and the results of a DWBA calculation. (auth)

7751 LOW-ENERGY (p,n) REACTION ON ^{55}Mn AND THE LOW-LYING EXCITED STATES OF ^{55}Fe. Uchida, Akira; Nagamine, Kanetada; Imaizumi, Minoru; Kamitsubo, Hiromichi; Kobayashi, Shinsaku (Tokyo Univ.). J. Phys. Soc. Jap., 21: 2115-22 (Nov. 1966). (NP-16375).

The (p,n) reaction on ^{55}Mn was studied with the emphasis on the investigation of the low-lying states of ^{55}Fe. The angular distributions of each neutron groups corresponding to energy states of ^{55}Fe lower than 0.93 MeV were measured at ten different proton energies in the energy range from 2.3 to 2.8 MeV. Levels of ^{55}Fe at 0.51 and 0.68 MeV reported by Kim at ORNL were not observed. The integrated cross section of each group corresponding to the low-lying states of ^{55}Fe was analyzed by means of the statistical theory of Hauser and Feshbach. As a consequence, the spin and parity of 0.41-MeV level were determined to be $\frac{1}{2}^-$; $\frac{3}{2}^-$ was excluded. This assignment is consistent with that suggested by Schiffer et al. The measurement of the life of the first excited state at 0.41 MeV was attempted as a test of core-excitation model. (auth)

7752 ELASTIC AND INELASTIC SCATTERING OF 55 MeV PROTONS FROM ^{60}Ni. Koike, Masahiro; Matsuda, Kazuhisa; Nonaka, Itaru; Saji, Yoshio; Yagi, Kohsuke; Ejiri, Hiroyasu; Ishizaki, Yoshihide; Nakajima; Yutaka; Tanaka, Eiji (Tokyo Univ.). J. Phys. Soc. Jap., 21: 2103-10(Nov. 1966).

The elastic and inelastic scattering of protons from ^{60}Ni was studied using a 55-MeV proton beam. Momentum spectra of the scattered particles were obtained with a broad-range magnetic spectrometer operated with energy resolution of about 1%. The angular distributions for elastic and inelastic scattering were measured between 2.3 and 88°. Optical-model parameters were adjusted to reproduce the angular distribution for the elastic scattering. The analysis based on the distorted-wave Born approximation was made for the inelastic angular distributions assuming direct excitation. The interaction potential for the first order collective excitation was employed with real coupling. Good agreement with experiments was obtained. The effective deformation parameters β_l were evaluated. The reduced transition ratio to the single particle value is discussed. (auth)

7753 PROTON WIDTHS OF EXCITED STATES IN ^{29}P BY THE $^{28}Si(^3He,d)^{29}P$ REACTION. Ejiri, H.; Ishimatsu, T.; Yagi, K.; Breuer, G.; Nakajima, Y.; Ohmura, H.; Tohei, T.; Nakagawa, T. (Tokyo Univ.). J. Phys. Soc. Jap., 21: 2110-15(Nov. 1966).

The low-lying states in ^{29}P were excited by the reaction $^{28}Si(^3He,d)^{29}P$. The analysis of the reaction in terms of the direct-reaction process yielded the orbital angular momenta of the transferred protons and the relative values of the proton widths. The reduced proton width obtained is generally in agreement with the values predicted on the Nilsson model with small deformation. A number of low-lying levels were found to have very small proton widths. This fact is accounted for as the effects of the rotational excitation and the band mixing of the excited levels. The measurement of the nucleon width may be useful to clarify the property of the excited level. (auth)

7754 AVERAGE CROSS SECTIONS AND HALF-LIVES OF ^{197m}Au AND ^{89m}Y EXCITED BY INELASTIC SCATTERING OF REACTOR NEUTRONS. Durrani, S. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Koehler, W. Trans. Amer. Nucl. Soc., 9: 479-81(Oct.-Nov. 1966).

7755 NEUTRON RADIATIVE CAPTURE CROSS-SECTION MEASUREMENTS FROM 1 eV TO 1 MeV ON LIGHT- AND MEDIUM-WEIGHT NUCLEI. Hockenbury, R. W.; Bartolome, Z.; Fullwood, R. R.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 9: 479(Oct.-Nov. 1966).

7756 INVESTIGATION OF GAMMA RAYS FROM INELASTIC PROTON SCATTERING AND RADIATIVE PROTON CAPTURE BY ^{26}Mg. Koval, A. A.; Kopanets, E. G.; Korda, Yu. S.; Sukhotin, L. N.; Tsytko, S. P. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 11: 1066-74(Oct. 1966). (In Ukrainian).

The $^{26}Mg(p,p'\gamma)^{26}Mg$ and $^{26}Mg(p,\gamma)^{27}Al$ reactions were investigated in the range of proton energy from 2.3 to 3.0 MeV. 35 resonances due to the $^{26}Mg(p,p'\gamma)^{26}Mg$ reaction were discovered. The angular distributions of 1.82-MeV γ rays were measured for 31 resonances. The angular distributions of 2.21-MeV γ rays from the $^{26}Mg(p,\gamma)^{27}Al$ reaction were measured for 14 resonances. The possible values of the spin and parity of the resonance levels of ^{27}Al are defined by means of the χ^2 criterion. A comparison of the properties of ^{27}Al levels excited in $^{26}Mg(p,p'\gamma)^{26}Mg$ and $^{26}Mg(p,\gamma)^{27}Al$ reactions is carried out. Most of the levels due to $^{26}Mg(p,p'\gamma)^{26}Mg$ and $^{26}Mg(p,\gamma)^{27}Al$ reactions are in good agreement. (auth)

7757 NUCLEAR SPECTROSCOPIC CALCULATIONS WITHOUT REPULSIVE CORE EFFECTS. Ghai, Urmil; Kumar, Naresh; Sood, Brij (Panjab Univ., Chandigarh, India). Progr. Theoret. Phys. (Kyoto), 36: 664-6(Sept. 1966).

The energy-level spectrum of ^{50}Ti was calculated using the shell model with soft-core and velocity-dependent potentials. The results were compared with experimental observations. The analysis indicates that soft-core potentials are better than velocity-dependent potentials for nuclear spectroscopic calculations without repulsive core effects. (D.C.W.)

7758 REVISED A-CHAINS AND ADJUSTED MASS DIFFERENCES FOR A = 77 TO 83. Nucl. Data, Sect. B, 1: B1-4-1-150 (Sept. 1966).

Revised A-chains and adjusted mass differences are presented for A = 77 to 83. (D.C.W.)

7759 SELF-CONSISTENT SET OF THERMAL NEUTRON ACTIVATION CROSS SECTIONS. Kappe, David Syme. University Park, Pa., Pennsylvania State Univ., 1965. 151p.

Thesis.

The thermal neutron activation cross sections of a number of nuclides were determined. These cross sections were measured relative to the cross section of a selected "standard nuclide" through the use of chemical compounds of the standard nuclide and the nuclides of interest (a technique analogous to the classical determination of the atomic weights through weight ratios referred to silver). This method eliminates the uncertainty in the relative amounts of the nuclides and minimizes the uncertainty in the neutron flux during irradiation. Also the resolution of the induced activities in the chosen compounds was by decay curve analyses of the numerous activity measurements made on each of the radioactive compounds. These statistical analyses were effected by the minimum chi-squared method and were executed by a modern high-speed digital computer. ^{23}Na, because of its 1/v character and many other favorable properties, was selected as the standard nuclide. The nuclides whose cross sections were compared to the sodium cross section are: ^{31}P, ^{34}S, ^{37}Cl, ^{41}K, ^{75}As, ^{127}I, and ^{35}Cl. The activity inducing process is the (n,γ) reaction in each case, except for ^{35}Cl, which undergoes the (n,p) reaction to give the radionuclide ^{35}S. The compounds through which the comparisons were made are: $NaNH_4PO_4 \cdot 4H_2O$, $Na_2S_2O_3 \cdot 5H_2O$, NaCl, KCl, KH_2PO_4, Na_4HAsO_4, NaI, and NH_4Cl. Each compound was carefully chosen and its purity was checked by activation analyses. The cross sections of ^{42}K and ^{35}Cl were not compared directly to that of sodium, however, but to the cross sections of ^{37}Cl and ^{31}P, and ^{35}Cl, respectively, which were directly compared to the sodium cross section. The product of the following ratios $\sigma(^{37}Cl)/\sigma(^{23}Na)$, $\sigma(^{41}K)/\sigma(^{37}Cl)$, $\sigma(^{31}P)/\sigma(^{41}K)$, and $\sigma(^{23}Na)/\sigma(^{31}P)$ should be one if this set of ratios is self-consistent. The product is actually 1.02 ± 0.05, which shows the set to be self-consistent indeed—at least well within a single standard deviation. The agreement between the two values obtained for the $\sigma(^{41}K)/\sigma(^{37}Cl)$ ratio demonstrates the remarkable reproducibility of this method.

The half lives of ^{24}Na and ^{38}Cl were also measured, the decay of each radionuclide being followed for more than five half-life periods. Both sets of decay data were analyzed by the minimum chi-squared method, which yielded a sodium half-life value of 15.01 ± 0.005 hours and chlorine half-life value of 37.14 ± 0.035 min. (Dissertation Abstr.)

7760 CROSS SECTIONS AND ISOMERIC YIELD RATIOS FOR (d,p) AND (d,n) REACTIONS. Natowitz, Joseph Bernard. Pittsburgh, Univ. of Pittsburgh, 1965. 143p.

Thesis.

The stacked target technique was used to measure absolute cross sections and isomer yield ratios ($\sigma_{\text{High Spin}}/\sigma_{\text{Low Spin}}$) for isomeric pairs produced by (d,p) and (d,n) reactions induced by deuterons of energy ≤15 MeV. Data were obtained for the (d,p) reactions leading to ^{60m,g}Co, ^{90m,g}Y, ^{104m,g}Rh, ^{111m,g}Pd, ^{115m,g}Cd, ^{134m,g}Cs, ^{182m,g}Ta, ^{188m,g}Re, and ^{197m,g}Pt; and for the (d,n) reactions leading to ^{93m,g}Tc and ^{95m,g}Nb. The (d,p) isomer ratios increase gradually with energy from values at a few MeV which are only slightly greater than the (n,γ) isomer ratios for production of the same isomeric pairs. At 14 MeV, the values of the (d,p) isomer ratios decrease from ~1 to ~0.1 as the difference in spin between the target and the high spin isomer increases from 1½ to 6½. For (d,p) reactions on even-even targets at 15 MeV, isomer ratios in good agreement with experiment have been calculated by combining structural information with distorted-wave Born approximation stripping calculations. In the (d,n) reactions, the ^{95m,g}Nb isomer ratio is essentially constant at 1.3, while the ^{93m,g}Tc isomer ratio rises from 1.9 at ~4 MeV to 4.3 at ~15 MeV. Stripping calculations similar to those performed for the (d,p) isomer ratios give good agreement in the case of ^{95m,g}Nb but not for ^{93m,g}Tc. Calculations based on compound nucleus mechanism for the (d,n) reactions give fair agreement for ^{93}Tc but not for ^{95}Nb. It is suggested that the ^{94}Zr(d,n)^{95m,g}Nb reaction is predominantly a stripping reaction while the ^{92}Mo(d,n)^{93m,g}Tc reaction involves a large compound nucleus contribution. A half life of 18.5 ± 0.3 min was found for $^{188\,m}$Re. For $^{111\,m}$Pd, the total internal conversion coefficient was found to have a value of 1.32 ± 0.14. (Dissertation Abstr.)

7761 ANGULAR CORRELATION STUDIES OF THE ^{32}S(d,pγ)^{33}S REACTION. O'Dell, Jean Marland. Lawrence, Kan., Univ. of Kansas, 1965. 98p.

Thesis.

Angular correlation studies with the special geometry suggested by Litherland and Ferguson (Can. J. Phys., 39: 788(1961)) were made to obtain spectroscopic information about the low-lying states of ^{33}S. These experiments permitted not only assignments of spin, but also provided valuable information about the decay characteristics and multipole mixing ratio, δ, of the gamma radiation. The results show that the population parameter method of Litherland and Ferguson can be used successfully to analyze the angular distributions of the gamma rays from (d,pγ) reactions. A method of detecting the presence of compound nucleus formation as a competition to the direct-interaction mechanism is also suggested. (Dissertation Abstr.)

7762 MASS MEASUREMENTS OF SOME PROTON-RICH NUCLEI. Miller, Richard Graham. Pasadena, Calif., California Inst. of Tech., 1966. 195p.

Thesis.

The Q values and 0° cross sections of (^{3}He,n) reactions forming seven proton-rich nuclei were measured with accuracies varying from 6 to 18 keV. The Q values (in keV) are: ^{26}Si(85), ^{30}S(−573), ^{34}Ar(−759), ^{42}Ti(−2865), ^{48}Cr(5550), ^{56}Ni(4513), and ^{60}Zn(818). At least one excited state was found for all but ^{42}Ti. The first four nuclei complete isotopic spin triplets; the results obtained agree well with charge-symmetry predictions. The last three, all multiples of the α particle, are important in the α and e-process theories of nucleo-synthesis in stars. The energy available for β decay of these three was found by magnetic spectrometer measurements of the (^{3}He,p) Q values of reactions leading to ^{48}V, ^{56}Co, and ^{60}Cu. Many excited states were seen: ^{48}V(3), ^{56}Co(15), ^{60}Cu(23). The first two states of ^{30}S are probably 0^+ and 2^+ from (^{3}He,n) angular distribution measurements. Two NaI γ measurements are described: the decay of ^{34}Ar (measured $\tau_{½}$ = 1.2 ± 0.3s) and the prompt γ spectrum from ^{54}Fe (^{3}He,nγ)^{56}Ni. Possible collective structure in ^{56}Ni and ^{40}Ca, both doubly magic, is discussed. The (^{3}He,n) neutron energy and yield measurements utilized neutron-induced nuclear reactions in a silicon semiconductor detector. Cross sections for the most important detection processes, ^{28}Si(n,α)^{25}Mg and ^{28}Si(n,p)^{28}Al, are presented for reactions leading to the first four states of both residual nuclei for neutron energies from 7.3 to 16.4 MeV. Resolution and pulse-height anomalies associated with recoil ^{25}Mg and ^{28}Al ions are discussed. The 0° cross section for ^{9}Be(α,n)^{12}C, used to provide calibration neutrons, was measured with a stilbene spectrometer for n_0 ($5.0 \le E_\alpha \le 12$ MeV), n_1($4.3 \le E_\alpha \le 12.0$ MeV), and n_2($6.0 \le E_\alpha \le 10.1$ MeV). Resonances seen in the n_0 yield may correspond to nine previously unreported levels in ^{13}C. (Dissertation Abstr.)

7763 MEASUREMENT OF 2p3/2-1f7/2 INTERACTION PARAMETERS. Schwartz, John Jay. Rochester, N. Y., Univ. of Rochester, 1966. 78p.

Thesis.

The interaction between two nucleons in different shells may be expressed in terms of the parameters $\overline{E^2}$ and ΔE^2. In the case of a $2p_{3/2}$ proton and $1f_{7/2}$ neutron the quantity $\overline{E^2}$ is the average $2p_{3/2}$ $1f_{7/2}$ two-body interaction energy. ΔE^2 is the average splitting between the T = 0 and T = 1 levels of given spin for a $2p_{3/2}$ $1f_{7/2}$ proton-neutron pair. To determine these parameters, the reactions ^{42}Ca(^{3}He,d)^{43}Sc and ^{44}Ca(^{3}He,d)^{45}Sc were studied at beam energies of 10 to 12 MeV. Angular distributions of emergent deuterons were obtained for transitions to levels up to 6 MeV in excitation. The angular distributions and absolute cross sections were fit extremely well with distorted-wave Born approximation calculations. To determine the spin of several ^{42}Sc levels reached by p-wave transitions, angular anisotropies in several proton-gamma correlations were measured in the reaction ^{40}Ca(α,pγ)^{43}Sc. A spin and parity of $^3/_2^-$ was assigned to the 0.475-, 1.180-, and 1.812-MeV levels of ^{43}Sc. Spectroscopic factors were extracted for levels reached by p wave transitions and from these the values of $\overline{E^2}$ and ΔE^2 for the $2p_{3/2}$ $1f_{7/2}$ interaction were determined. The values are −0.60 ± 0.15 and 3.3 ± 0.3 MeV for $\overline{E^2}$ and ΔE^2, respectively. (Dissertation Abstr.)

7764 CROSS SECTIONS OF SOME (n,p), (n,t), AND (n,α) REACTIONS IN THE NEUTRON ENERGY REGION 13 TO 19 MeV. Bormann, M.; Dreyer, F.; Neuert, H.; Riehle, I.; Zielinski, U. (Univ., Hamburg). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/81, 12p. (CONF-661014–11). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The activation method was used for measuring the cross sections of some neutron reactions at several neutron energies in the region 13 to 19 MeV. Results are presented in tabular form for (n,p) reaction with ^{16}O, ^{25}Mg, ^{34}S, ^{58}Ni, ^{75}As, ^{74}Se, and ^{85}Rb, for (n,t) reactions with ^{32}S and ^{40}Ca, and for (n,α) reactions with ^{26}Mg, ^{75}As, and ^{85}Rb. Monochromatic neutrons were produced by the reaction ^{3}H(d,n)^{4}He in titanium−tritium targets using the deuteron beams of a 3-MeV or a 1.5-MeV Van de Graaff generator. Gamma and positron activities were detected by means of a 3″ × 2″ NaI well crystal or a γγ coincidence spectrometer consisting of two 3″ × 3″ NaI crystals. A pneumatic sample transport system was used in those cases where the activities had short half-lives. The neutron flux was measured by counting the recoil protons in a stilbene crystal. Most of the (n,p) and (n,α) reactions investigated in the present work reach a maximum cross-section in the energy region considered. From these results and from corresponding data in the literature a simple expression can be deduced for the approximate determination of the neutron energy E_0^{max} at which the (n,p) and (n,α) reactions reach their maximum cross-section as long as the target nuclei are restricted to the mass region of 20 ≤ A ≤ 100. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 6232, 7458, 7674, 7688, 7694, 7721, 7747, 7827, 7832, and 7842.

7765 (AERE-NP-R-1912) MEASUREMENT OF THE AVERAGE NUMBER OF PROMPT NEUTRONS EMITTED IN FISSION AT HIGH ENERGY. Johnstone, I. (Atomic Energy Research Establishment, Harwell (England)). Mar. 20, 1956. 16p. Dep. mn.

A coincidence gate method has been used to determine $\bar{\nu}$, the average number of neutrons emitted in fission, induced by neutrons at 2.5 and 14.1 MeV energy. Absolute values have been obtained by relating the measurements to the known spontaneous fission neutron rate of natural uranium. Some results are given for the fast fission of ^{233}U, ^{235}U, ^{238}U, ^{232}Th, and ^{239}Pu, and for spontaneous fission of ^{240}Pu. (auth)

7766 (AERE-RP/R-1655) RELATIVE NEUTRON YIELDS FROM INDUCED FISSION OF ^{239}Pu AND SPONTANEOUS FISSION OF ^{240}Pu. Sanders, J. E. (Atomic Energy Research Establishment, Harwell (England)). May 13, 1955. 8p. Dep. mn.

A direct comparison was made of the prompt neutron yield in spontaneous fission of ^{240}Pu with that in slow-neutron induced fission of ^{239}Pu. The measurements on ν for induced fission were

made by admitting a neutron beam from the BEPO reactor to the experimental apparatus, while the work on spontaneous fission was done with the reactor shutdown. The comparisons were thus made under identical geometrical conditions. A total of 3188 spontaneous and 9776 induced fission neutron counts was accumulated in the experimental runs. Taking a weighted mean of the results, and correcting for the effect of ^{241}Pu in the induced-fission runs and for possible neutron spectrum differences, a value of ν(spont.)/ν(induced) = 0.759 ± 0.028 was obtained. (S.F.L.)

7767 (CF-60-2-84) MANGANESE BATH MEASUREMENTS OF η OF ^{233}U AND ^{235}U. Macklin, R. L.; deSaussure, G.; Kington, J. D.; Lyon, W. S. (Oak Ridge National Lab., Tenn.). Mar. 15, 1960. Contract W-7405-eng-26. 78p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The absolute thermal value of η for ^{233}U and ^{235}U was measured directly by a method of total absorption which involves relative counting of manganese bath activations and some minor corrections. A thermal neutron beam (defined by cadmium difference) is introduced in the center of a one-meter-diameter sphere filled with a dilute solution of manganous sulfate in water. The beam is first made to activate the bath directly, then it is totally absorbed in the fissionable sample whose fission neutrons then activate the bath. The ratio of the two activities is equal to η, except for small corrections. The results obtained for η corrected to 2200 m/sec were, for ^{233}U, 2.296 ± 0.010; and for ^{235}U, 2.077 ± 0.010. (auth)

7768 (HW-71984) "ACTICAY" FISSION PRODUCT DECAY PROGRAM. Johnson, D. L. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Dec. 10, 1961. Contract AT(45-1)-1350. 12p. DTIE.

A description is given of the computer program ACTICAY (for fission product activity decay) which is an IBM-7090 Fortran code designed to give the activity in megacuries as a function of time (greater than 100 sec) after reactor shutdown for any fission product isotope. (S.F.L.)

7769 (IN-1033) VARIATION WITH NEUTRON ENERGY OF THE YIELD OF HIGH KINETIC ENERGY FRAGMENTS FROM ^{233}U, ^{235}U, AND ^{239}Pu. Miller, L. G.; Moore, M. S. (Idaho Nuclear Corp., Idaho Falls). Nov. 1966. Contract AT(10-1)-1230. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A fission chamber was devised which detects with high efficiency those fission events in which the kinetic energy release of the heavier binary fragment is maximal. This detector was used, in conjunction with a conventional fission detector (whose efficiency is independent of fragment energy), in a study of the relative yield of high kinetic energy fission of ^{233}U, ^{235}U, and ^{239}Pu, induced by low-energy neutrons. The variations in the yield of high kinetic energy fragments indicate a qualitative correlation with results of measurements of the relative symmetric fission yield as a function of neutron energy. This correlation, however, suggests that the increased relative symmetric fission is accompanied by an increased relative yield of high kinetic energy fragments, contrary to what was previously assumed on the basis of current models of the fission process. (auth)

7770 (LA-DC-7864) NEUTRON CROSS-SECTION MEASUREMENTS OF RADIOACTIVE NUCLIDES USING NEUTRONS FROM AN UNDERGROUND NUCLEAR EXPLOSION. Brown, W. K.; Diven, B. C.; Seeger, P. A. (Los Alamos Scientific Lab., Univ. of California, N. Mex. [1966]. Contract W-7405-eng-36. 18p. (CONF-660817-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden.

The method developed at the Los Alamos Scientific Laboratory of using time-of-flight techniques in combination with a neutron burst from the underground detonation of a nuclear explosive has opened new possibilities in neutron cross-section measurement. The enormously high neutron flux generated in such a burst can be used to give correspondingly large reaction rates in targets. An obvious exploitation of this circumstance lies in the measurement of the cross sections of radioactive nuclides. Such measurements are often impossible using conventional neutron sources due to the high radioactive background, the rapid disappearance of the target, or both. With large reaction rates, the radioactive background becomes relatively small, and the amount of sample does not change significantly in the several milliseconds during the measurement. Having demonstrated the efficacy of the method in general on the Petrel event in June 1965 at the Nevada Test Site, efforts are being directed specifically to measurements of the cross sections of radioactive isotopes. In the autumn of 1966 it is planned to measure the capture cross section of ^{147}Pm (2.7 y), a fission product from which, through neutron capture, the reactor poison ^{148}Pm is synthesized. Plans for future measurements include the capture cross section of ^{148}Pm (41 d), ^{233}Pa (27.4 d), and possibly the fission cross section of ^{235m}U (26.2 m) which would require fast chemistry under field conditions. Measurements on nuclides increasingly further from the stability line are planned. These measurements will provide basic nuclear structure information not otherwise presently obtainable. Measurement of these cross sections will strengthen the knowledge of the systematics among radioactive nuclides and lower the uncertainties in the extrapolation necessary for the analysis of r-process nucleosynthesis. (auth)

7771 (NYO-2098-1) NUCLEAR REACTIONS IN LIGHT NUCLEI AND MOESSBAUER STUDIES. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). Nov. 1966. Contract AT(30-1)-2028. 237p. Dep. mn. CFSTI $6.00 cy, $1.25 mn.

The effect of Coulomb excitation on Moessbauer spectra of ^{57}Fe in Fe and F_2O_3 was investigated; and Moessbauer experiments were performed on ^{164}Dy, ^{168}Er, ^{155}Gd, ^{156}Gd, ^{158}Gd, ^{160}Gd, and ^{174}Yb using Coulomb excitation. Ratios of quadrupole moments were obtained for the even-even isotopes of Gd. Well-resolved magnetic hyperfine structure was observed in ^{164}Dy and ^{168}Er, and estimates of the magnetic energy splitting were obtained. Unresolved quadrupole structure was observed in ^{174}Yb, and the quadrupole interaction energy was determined. Moessbauer levels were observed in ^{172}Yb, ^{174}Yb, and ^{176}Yb following the population of the first excited states by Coulomb excitation; the quadrupole energy splittings and relative quadrupole moments were determined for each isotope. The electric field gradient at the nucleus and the asymmetry parameter for Yb in Yb_2O_3 were obtained from Coulomb excitation cross-section data. In addition, the magnetic moment and spin of the second excited state of ^{57}Fe was determined by observing the Moessbauer effect of the 136.4-keV decay. Moessbauer measurements on ^{155}Gd gave a lower limit for the lifetime of the first excited state and indicated a spin of $\frac{1}{2}$ for the second excited state as well as a quadrupole splitting of 9.3×10^{-7} eV for the ground state. Hyperfine interaction energies of ^{170}Yb in Yb_2O_3 and $YbCl_3 \cdot 6H_2O$ were also measured using Moessbauer techniques. Equipment was developed for Moessbauer studies at high and low temperatures, and experiment was prepared for the observation of polarization from the reaction ^{56}Fe(d,p)^{57}Fe, using the Moessbauer effect. The polarization of the ^{12}B recoil nuclei from the reaction ^{11}B(d,p)^{12}B was investigated as a function of deuteron energy, recoil angle, and the types of recoil stopping material-angular distributions and excitation functions for the reaction ^{19}F(d,n)^{20}Ne were measured in the energy range from 0.9 to 2.7 MeV; the angular distributions were analyzed in terms of a dual-mode plane-wave theory that incorporates exchange and interference terms. Li-drifted Ge gamma detectors were fabricated and tested, and a magnetic spectrometer was developed for Moessbauer studies. A prototype of a large-area neutron detector using slabs of scintillator was also constructed. (D.C.W.)

7772 (TID-23362) THE AUGER, INTERNAL CONVERSION AND GAMMA-RAY SPECTRA FROM THE DECAY OF ^{233}Pa AND AN INVESTIGATION OF THE EFFECT OF PHOTOELECTRON SCATTERING ON THE IEC METHOD. Zender, Michael Joseph (Vanderbilt Univ., Nashville, Tenn.). Aug. 1966. Contract AT(40-1)-1087. 147p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. Thesis.

The results of an investigation of the Auger, internal-conversion, Coster-Kronig, and gamma spectra of ^{233}U from the decay of ^{233}Pa are presented, and a decay scheme is proposed for ^{233}Pa. The effects of photoelectron scattering on the f factor used in the internal-external method for determining conversion coefficients was also investigated. (D.C.W.)

7773 (UCID-15036) STATUS REPORT TO THE NCSAG. Fultz, S.C. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 14, 1966. Contract W-7405-eng-48. 30p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The neutron scattering cross sections of ^{241}Pu and ^{233}U were measured from 2 to 32 eV and from 1 to 20 eV, respectively. The thermal-neutron capture cross sections of Ca, ^{42}Ca, ^{43}Ca, and ^{44}Ca were also measured as was the capture cross section of ^{255}Fm in a moderated reactor spectrum. The cross section of the reaction ^{14}N(n,p)^{14}C was investigated as a function of energy between 5 and 13 MeV, and the neutron fission cross section of ^{242m}Am was measured from 0.02 to 6 MeV. The spontaneous fission half life of ^{242m}Am was also measured as was the average number of neutrons per thermal-neutron fission of ^{242m}Am. A corona-type spark chamber was used to measure the neutron fission cross section of ^{232}U from 4 eV to 2 keV, and photoneutron cross sections for ^{89}Y, ^{90}Zr, ^{91}Zr, ^{92}Zr, and ^{94}Zr were measured as a function of energy up to 30 MeV. In addition, threshold photoneutron cross sections were measured for Be and Fe. A Fortran code for analyzing cross-section data for resonance parameters using a multilevel formula was written for the CDC 6600 computer, and a Maxon-Rae-type gamma detector using multiple gamma-to-electron converter plates to give improved efficiency was developed. (D.C.W.)

7774 (UCRL-16489) FISSION PROPERTIES OF SOME ELEMENTS BELOW RADIUM. Khodai-Joopari, Arastoo (Lawrence Radiation Lab., Univ. of California, Berkeley). July 11, 1966. Contract W-7405-eng-48. 195p. Dep. mn. CFSTI $5.00 cy, $1.00 mn.

Thesis.

The fission cross sections σ_f were measured in bombardments of ^{209}Bi, ^{208}Pb, ^{207}Pb, and ^{206}Pb with helium ions of energies 25 to 130 MeV and ^{209}Bi, ^{208}Pb, ^{206}Pb, and ^{197}Au with protons of energies 15 to 30 MeV, using (mainly) mica for the detection of fission fragments. From the comparison of the low-energy σ_f/σ_R data with different theoretical expressions for Γ_f/Γ_n, the heights of the fission barriers, B_f, for ^{213}At, ^{212}Po, ^{210}Po, ^{209}Bi, ^{207}Bi, and ^{198}Hg were deduced. The accuracies of the relative and absolute values of B_f are 0.5 and 1.5 MeV, respectively. It is found that the ratio a_f/a_n is quite different (1.5 to 1.2) for these nuclei, indicating that the influence of shell effects on the level densities is still strong at moderately high excitation energies (≈16 to 40 MeV). A comparison of the relative values of B_f with the predictions of the conventional liquid-drop model seems to show that one obtains somewhat better agreement if a composition-dependent surface energy is used. Therefore, the values of B_f are compared with those calculated by Myers and Swiatecki (M-S) which show fairly good gross agreement. However, the saddle masses plotted relative to the smooth liquid-drop reference mass surface of M-S show a structure similar to, but much less pronounced than, that corresponding to the ground-state masses. If this structure is taken as an indication for the existence of shell effects at the saddle point, the anomaly between the experimental and theoretical values of B_f for the heavy elements and the fission-barrier systematics can be qualitatively explained. A discussion is given of the possibility that shell effects at the saddle point may affect the interpretation of the observed features of low- and medium-energy fission, along with a brief review of some of the experimental observations and theoretical viewpoints in this connection. Various aspects of the higher-energy σ_f/σ_R data are qualitatively discussed. It is shown that within the framework of the Fermi-gas model the level density parameter a_n has to increase with energy in order to account for the large discrepancy observed between the σ_f/σ_R data and the calculated values of $\Gamma_f/(\Gamma_f + \Gamma_n)$ extended to higher energies. Semiquantitative estimates of "first-chance" fission (for ^{212}Po and ^{211}Po) and of the numbers of prefission neutrons ($\bar{\nu}_p$) are made and compared with estimates of ($\bar{\nu}_p$) made by others in similar cases. The importance of such estimates for a correct interpretation of various distributions of fission fragments and the possibility of usefulness of these σ_f/σ_R data for a quantitative study of the behavior of level densities with energy is pointed out. (auth)

7775 (UCRL-16888) NUCLEAR SPECTROSCOPIC STUDIES OF SOME VERY HEAVY ODD-MASS NUCLIDES. Ahmad, Irshad (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 20, 1966. Contract W-7405-eng-48. 134p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The nuclear radiations of the nuclides ^{233}U, ^{239}Pu, ^{243}Bk, ^{244}Bk, ^{245}Bk, ^{246}Bk, ^{249}Bk, ^{249}Cf, and ^{255}Fm were investigated with high-resolution spectrometers. The α-particle spectra of all nuclides except ^{249}Bk were measured with 6 mm diameter surface-barrier detectors. ^{249}Bk α particles were analyzed with a double-focusing magnetic spectrograph. The γ-singles were examined with the recently developed Ge(Li) and Si(Li) detectors coupled with very low noise "internal FET" preamplifiers. Weak alpha groups were observed in coincidence with γ-rays, detected with a NaI(Tl) scintillation spectrometer. To improve the over-all coincidence efficiency a new coincidence apparatus was designed and built. This instrument consisted of a cooled 4.5 cm diameter semiconductor detector for α-particle detection and a 3 cm diameter by 2.7 cm long Ge(Li) detector for γ-ray analysis. The Ge(Li) detector could also be replaced with a NaI(Tl) detector. ^{249}Cf conversion electrons were measured with a cooled Si(Li) detector coupled with an internal FET preamplifier. On the basis of the present work and previous information, energy-level diagrams of the daughter nuclei have been constructed. The levels have been grouped into rotational bands built on Nilsson single-particle states. Because of identification of several rotational members of the bands, definite Nilsson quantum number assignments have been made in most cases. The alpha intensity calculations of Poggenburg were found quite helpful in making these assignments. A strong Coriolis effect was observed in the ^{245}Am levels populated by the alpha groups of ^{249}Bk. Calculations were made with Nilsson wavefunctions, and these were found to agree with the experimental results. The Coriolis interaction was found important in almost all cases; the effect was very noticeable in the level spacings between the rotational members of the bands. High-lying bands in ^{245}Cm (at 644 keV) and ^{251}Cf (at 550 keV) were observed and 4 rotational members of each were identified. The modes of de-excitation of these levels indicate very small or no vibrational characters in them. This suggests that the vibrational bands in this region lie at very high energies (~1 MeV) above the ground state. (auth)

7776 (ANL-Trans-371) POLARIZATION EFFECTS IN THE COULOMB SCATTERING OF 4-MeV NEUTRONS BY COPPER, LEAD, AND URANIUM NUCLEI. Gorlov, G. V.; Lebedeva, N. S.; Morozov, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated by Elmar K. Wilip (Argonne National Lab.), from report IAE-1053. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fs, $0.80 mf.

A brief discussion is given of results obtained from the experimental scattering of polarized 4-MeV neutrons over the angles 2, 4, and 6 by Cu, Pb, and U nuclei. It is shown that within the limits of experimental error the concepts developed by Schwinger with respect to the Coulomb scattering of neutrons agree with the measured results, so that it can be assumed that with the scattering of neutrons of such an energy the polarization effects in the small angle region are determined essentially by the Coulomb scattering. The Coulomb polarization capacity of Cu, Pb, and U was calculated on the basis of experimental data for the elastic scattering of neutrons in the angular range $30' \leq \theta \leq 6°$. The polarization in the scattered neutron beam from the D(d,n) reaction was determined as equal to $(15.8 \pm 1.6)\%$. Estimates of the magnitude of the square of the real part of the amplitude of the potential nuclear forward scattering were made. (auth)

7777 EXPERIMENTAL STUDIES ON THE CORRECTION FACTOR FOR THE EXTERNAL CONVERSION METHOD OF GAMMA-RAY MEASUREMENTS. Mitsui, Hidehiko (Hitachi Ltd., Kawasaki, Japan). J. Phys. Soc. Jap., 21: 2097-2102(Nov. 1966).

The correction factor in the external-conversion method due to anisotropy of photoelectrons was calculated using two kinds of angular distribution functions. The calculated correction factors were compared with each other and were tested by measurement of internal and external conversion lines of ^{198}Au and ^{137}Cs. It was found that the correction factors calculated using angular distribution functions given by Hultberg are correct and that the effect of the Z-dependence of angular distribution functions on the correction factor is negligible for Z = 82 and 92. (auth)

7778 LIFETIME OF THE 321-keV LEVEL IN ^{125}Te. Inamura, Takashi; Iwashita, Takeki; Kageyama, Seizaburo (Tokyo Inst. of Tech.). J. Phys. Soc. Jap., 21: 2425(Nov. 1966).

The lifetime of the odd-parity, 321-keV level of ^{125}Te was measured using a β-γ delayed coincidence method. The M1/E2 mixing ratio of the 176-keV transition from this level was also studied. (D.C.W.)

7779 THE ENERGY LEVELS OF ^{129}Te. Tagishi, Yoshihiro (Tokyo Univ. of Education); Iwashita, Takeki; Kageyama, Seizaburo. J. Phys. Soc. Jap., 21: 2439-44(Dec. 1966).

The decay of ^{129}Sb was studied with Li-drifted germanium and scintillation spectrometers. Singles and β-γ and γ-γ coincidence spectra were observed. Gamma rays with energies 180, 296, 358, 410, 523, 544, 652, 683, 760, 813, 876, 916, 967, 1028, 1048, 1240, 1300, 1520, 1730, 1840 and 2070 keV and beta branches with endpoint energies 0.58, 0.70, 1.06, 1.55, 1.82 and 2.24 MeV were found. The relative intensities of these gamma and beta rays were estimated. The half life of ^{129}Sb was determined to be 4.35 ± 0.05 hr. The present data are consistent with a level scheme with states at 544, 813, 1227, 1637, 1729, 1841 and 2064 keV. (auth)

7780 ALPHA-ACTIVE IRIDIUM ISOTOPES. Siivola, Antii (Univ. of California, Berkeley. Univ. of Helsinki). Nucl. Phys., A92: 475-80(1967).

Seven alpha-active isotopes of Ir were found in ^{16}O and ^{19}F bombardments of thulium and erbium targets. The activities were observed by using a fast recoil collection apparatus, and they were identified by cross bombardments and excitation function measurements. The half lives and alpha energies of the Ir isotopes were measured. (auth)

7781 SPIN AND RESONANCE PARAMETERS OF THE 3.90-eV NEUTRON RESONANCE AND MAGNETIC HYPERFINE CONSTANT IN ^{169}Tm. Al-Kital, R. A.; Brunhart, G.; Malik, S. S.; Roberge, J. P.; Sailor, V. L. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Nucl. Phys., A91: 644-52 (1967). (BNL-10536).

The spin of the 3.9-eV neutron resonance in ^{169}Tm was determined to be $J = I + \frac{1}{2} = 1$ by measuring the transmission of polarized monoenergetic neutrons through a polarized target. The resonance parameters redetermined from total cross-section measurements are $E_0 = 3.90 \pm 0.02$ eV, $\Gamma_\gamma = 0.099 \pm 0.003$ eV, and $\Gamma_n = 0.0081 \pm 0.002$ eV. The variation of nuclear polarization with

temperature yields the value for the magnetic hyperfine constant $A/k = 0.206 \pm 0.014$°K in the nonsaturated ferromagnetic polycrystalline metal. (auth)

7782 NUCLEAR STRUCTURE EFFECTS IN THE 282 keV E1 CONVERSION PROCESS IN ^{175}Lu. Thun, J. E. (Uppsala Univ.). Nucl. Phys., A91: 653-8(1967).

The directional correlation between 282 K electrons and 114-keV gamma rays in ^{175}Lu was measured. The experimental particle parameter for the retarded 282-keV E1 transition was found to be $+0.28 \pm 0.06$ in serious disagreement with the theoretical (point nucleus) value −1.52. This discrepancy is interpreted as being due to nuclear structure effects on the conversion process, the largest penetration matrix element being more than two orders of magnitude larger than the radiation matrix element. (auth)

7783 THE g-FACTOR OF THE 633-keV LEVEL IN ^{188}Os. Keszthelyi, L.; Demeter, I.; Dezsi, I.; Pocs, L. (Central Research Inst. of Physics, Budapest). Nucl. Phys., A91: 692-6 (1967).

The g-factor of the 633-keV 2^+ K = 2 γ vibrational state in ^{188}Os was measured with the use of an internal magnetic field and was found to be 0.39 ± 0.12. The known values of the g-factor of the 155-keV, 2^+, K = 0 state and of the E2-M1 mixing parameter of the 478-keV radiation permitted the evaluation of the ratio of the strength of pairing forces for protons to that for neutrons as $G_p/G_n = 1.53 \pm 0.02$. (auth)

7784 COLLECTIVE VIBRATIONAL STATES IN EVEN Gd NUCLEI. Bloch, R.; Elbek, B.; Tjoem, P. O. (Univ. of Copenhagen). Nucl. Phys., A91: 576-92(1967).

The energy levels of the even nuclei of gadolinium were investigated by inelastic scattering of 12-MeV deuterons. The deuteron spectra were recorded in a magnetic spectrograph with an overall energy resolution of ≈8 keV. On the basis of semi-empirical rules governing the intensities and angular distributions of the inelastic groups, collective octupole and quadrupole vibrations were localized. As a rule, two or three octupole states were identified in each nucleus below an excitation energy of approximately 2.5 MeV. In the same region, the collective γ vibrations and, in some cases, β vibrations were identified. Only a few other groups were present. (auth)

7785 THE DETERMINATION OF THE STATIC QUADRUPOLE MOMENTS OF THE FIRST 2^+ STATES IN ^{114}Cd AND ^{116}Cd BY HIGHER ORDER EFFECTS IN COULOMB EXCITATION. Stokstad, R. G. (California Inst. of Tech., Pasadena); Hall, I.; Symons, G. D.; de Boer, J. Contract AT(04-3)-63. Nucl. Phys., A92: 319-44(1967). (TID-23429).

Measurements of the probabilities for Coulomb excitation of the first 2^+ states in ^{114}Cd and ^{116}Cd were made with ^{4}He, ^{12}C, and ^{16}O ions. The deviations observed from first-order perturbation theory are interpreted in terms of the static electric quadrupole moments Q_2 of the first 2^+ states of the two nuclei. The values of these static quadrupole moments are thus found to lie in the range $-0.54 > Q_2 > -0.90$ eb for ^{114}Cd and $-0.70 > Q_2 > -1.16$ eb for ^{116}Cd. The main uncertainty in Q_2 arises from a lack of knowledge of the signs of the E2 matrix elements to higher 2^+ states which also affect the excitation of the first 2^+ state. (auth)

7786 GROUND STATE (QUASI-) ROTATIONAL LEVELS IN LIGHT Os, Pt, AND Hg NUCLEI. Burde, J.; Diamond, R. M.; Stephens, F. S. (Univ. of California, Berkeley). Nucl. Phys., A92: 306-18(1967). (UCRL-17067).

Energy levels in some neutron-deficient doubly even nuclei in the platinum region were studied following heavy-ion reactions. Information on the ground-state rotational (or quasi-rotational) bands in ^{178}Os, ^{180}Os, ^{182}Os, ^{192}Pt, ^{194}Pt, ^{196}Pt, ^{198}Pt, ^{198}Hg, and ^{190}Hg is presented. The levels suggest that the light platinum nuclei are very soft axially-symmetric rotors, rather different from the well-known γ-unstable or tri-axial heavy osmium nuclei. The energy-level systematics of this region are compared with those of the samarium region, and it is concluded that the two regions are basically similar, with the well-known 88−90 neutron discontinuity reasonably well duplicated between neutron-deficient osmium and platinum nuclei (proton number 76−78). (auth)

7787 NUCLEAR STRUCTURE EFFECTS IN THE 343 keV M1 TRANSITION IN ^{175}Lu. Erman, P.; Deutch, B. I.; Herrlander, C. J. (Research Inst. for Physics, Stockholm). Nucl. Phys., A92: 241-52(1967).

The conversion coefficients of the 343-keV transition in ^{175}Lu were measured by the internal-external conversion method using an automatic 50-cm double-focusing spectrometer and various uranium converters. The experimental values are $\alpha_K = 0.086 \pm 0.004$, $\alpha_{L_1} = 0.0121 \pm 0.0005$, $\alpha_{L_2} = 0.00115 \pm 0.00007$, and $\alpha_{L_3} = 0.00028 \pm 0.00002$. From these conversion coefficients and the C_S coefficients of Nielsen, the penetration parameter of the 343-keV transition in ^{175}Lu is calculated to be $\lambda_{343} = +4.5 \pm 1.5$. The corresponding mixing ratio is found to be $\delta_{343} = 0.069 \pm 0.015$. These values are consistent with the Rose K, L_1, L_2, and L_3 or Sliv and Band K, L_1, and L_3 theoretical conversion coefficients. For complete consistency with all the theoretical conversion coefficients, the Sliv and Band $\beta_1(L_2)$ would have to be lowered by about 15%. From λ_{343}, the absolute value of λ for the 482-keV transition in ^{181}Ta is found to be $|\lambda_{482}| \approx 270 \pm 100$. Using the sign of λ_{343} in Wahlborn's theoretical analysis for the circular polarization P resulting from parity impurities in the 343-keV level of ^{175}Lu, the value of P is expected to be negative and of the order 10^{-4}. (auth)

7788 INVESTIGATIONS OF EMISSIONS FROM ^{94}Tc, ^{96}Tc, AND ^{87}Zr. Baskova, K. A.; Vasilev, S. S.; Khamo-Leila, M. A.; Shavtvalov, L. Ya. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 2255-63(Dec. 1965). (In Russian).

A magnetic β spectrometer and a scintillation γ spectrometer with 100-channel analyzers were used for investigating the β and γ spectra of ^{94}Tc, ^{96}Tc, and ^{87}Zr. The ^{94}Tc nuclide with $T_{1/2} = 52$ min was prepared by the ^{94}Mo(p,n) and ^{94}Mo(d,2n) reactions. As the $E_\gamma = 3200$ keV γ quanta did not yield coincidences with β particles, it was assumed that they reach the 3240-keV level after electron capture. In addition to $T_{1/2} = 52$ min, a half life of 295 ± 10 min was also established, indicating the existence of isomeric states. The ^{96}Tc with $T_{1/2} = 43$ days was obtained by irradiating ^{96}Mo with protons and deuterons; it exhibited γ lines with energies of 200, 320, 800, 1120, 1650, and 1950 keV, in agreement with previously reported findings. A half life of 51.5 min was also found; it was attributed to the isomeric ^{96*}Tc state, lying at 34 keV above the ground level. The ^{87}Zr with $T_{1/2} = 94$ min was obtained by the ^{84}Sr(α,d) reaction. The γ spectrum exhibited lines at 650, 1080, 1900, and 2500 keV, but they were attributed to the ^{86}Y formed by the ^{84}Sr(α,d) reaction and by the decay of ^{86}Zr. No γ lines of ^{87}Zr were observed. It is assumed that there is only one β transition between the ground state of ^{87}Zr and the isomeric state of ^{87}Y. (TTT)

7789 THE LEVEL SCHEME OF ^{145}Sm. Demeter, I.; Mol'nar, F.; Nadzhakov, E.; Novgorodov, A. F. (Joint Inst. for Nuclear Research, Dubna, USSR. Inst. of Nuclear Physics, Kazkh SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 2198-2204(Dec. 1965). (In Russian).

The isotope ^{145}Eu, used as the starting material for the study, was obtained as a product of α decay of ^{149}Tb which was obtained by irradiating a Ta target with 660-MeV protons in a synchro-cyclotron. The Tb fraction was separated radiochemically, while the Eu was removed chromatographically and by cementation with Na amalgam, in order to obtain highest purity. A coincidence-type scintillation γ-coincidence spectrometer with a NaI(Tl) crystal was used for the study. The half life of the nuclide, determined through the total count, was 6.0 ± 0.2 days. The decay scheme derived from the data obtained does not include the 1004- and 1140-keV levels which are included in previously published articles. The 542-, 653-, and 766-keV transitions also differ from previously accepted schemes; the 111-keV transition is located above the 543-keV transition. The 653-keV transition can not possibly start from the 1660-keV level because it is much more intense than the 111-keV transition which originates after the 653-keV transition. Taking into account the known parity of the ground state, the following spin and parity values were found: $7/2^-$, $3/2^-$, and $3/2^+$ for the 0, 893-, and 1547-keV levels respectively. (TTT)

7790 STRUCTURE OF THE GROUND AND EXCITED STATES OF ODD-MASS DEFORMED NUCLEI IN THE REGION $153 \leqq A \leqq 187$. Solovev, V. G.; Vogel, P. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., A92: 449-74(1967).

The interactions of quasi-particles with quadrupole and octupole phonons in deformed odd-mass nuclei are considered in the framework of the method of approximate second quantization. The properties of phonons are determined in investigating even-mass nuclei. In considering the interaction of quasi-particles with phonons in odd-mass nuclei, there is therefore not a single free parameter. The peculiarities of the secular equations are studied and it is shown that for many states, besides the interaction of quasi-particles with gamma-vibrational phonons, the interactions of quasi-particles with octupole and beta-vibrational phonons are very important. The energies and wave functions for the majority of odd-mass nuclei in the range $151 \leqq A \leqq 187$ are found. It is shown that the interaction of quasi-particles with phonons leads to the appearance of admixtures to the one-quasi-particle states and improves the description of these states as compared to the independent quasi-particle model. It is shown that this interaction leads to the formation of the collective non-rotational states and of the complex structure states in odd-mass nuclei. The calculated energies of the excited states, values of B(E2), the decoupling parameters a and the spectroscopic factors agree rather well with

the corresponding experimental data. It is concluded that the interaction of quasi-particles with phonons gives a correct description of the structure of the ground and excited states of deformed odd-mass nuclei. (auth)

7791 MOESSBAUER EFFECT IN ^{157}Gd. Prange, H.; Kienle, P. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 23: 681-2(Dec. 19, 1966).

The Moessbauer effect of the 64-keV γ ray in ^{157}Gd was observed, using Gd_2O_3 as the source as well as the absorber material at 4.2°K. The hyperfine structure splitting is large compared to the experimental line width. (auth)

7792 PRECESSION MEASUREMENTS FOLLOWING COULOMB EXCITATION WITH OXYGEN IONS. III. GYROMAGNETIC RATIOS OF ROTATIONAL STATES IN W ISOTOPES. Gilad, P.; Goldring, G.; Herber, R.; Kalish, R. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., A91: 633-43(1967).

A measurement of the g-factor of the $\frac{5}{2}^-$ state at 99 keV in ^{183}W is reported. Measurements are also described which make use of internal magnetic fields in saturated ferromagnetics. The value and sign of the internal fields acting on a tungsten nucleus in nickel, cobalt, and iron were determined with the aid of these fields. Precession measurements were carried out for the 4^+ levels in ^{182}W, ^{184}W, and ^{186}W. It is also established through the internal consistency of the results that the internal fields are set up during a time shorter than 5×10^{-11} sec. (auth)

7793 NEW ISOTOPES: ^{11}Li, ^{14}B, AND ^{15}B. Poskanzer, A. M.; Cosper, S. W.; Hyde, Earl K.; Cerny, Joseph (Univ. of California, Berkeley). Phys. Rev. Lett., 17: 1271-4(Dec. 19, 1966).

Data obtained with semiconductor detectors and a particle-identifier system on fragments ejected from uranium bombarded with 5.3-GeV protons show that ^{14}B, ^{15}B, and ^{11}Li are particle-stable; ^{10}Li is particle-unstable; and ^{13}Be is most probably particle-unstable. (auth)

7794 OPTICAL MODEL FOR 30-MeV PROTON SCATTERING. Satchler, G. R. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A92: 273-305(1967). (ORNL-P-2351).

The differential cross sections, polarizations, and absorption cross sections for the elastic scattering of 30-MeV protons from the nuclei Si, Ca, Fe, Ni, Co, Cu, Sn, and Pb were analyzed in terms of the optical model. A smaller radius and a larger surface diffuseness were obtained than have previously been inferred for the real potential. A volume absorption strength of about 3 MeV is required, while the surface absorption term increases in strength as A increases. The diffuseness of the imaginary potential is also larger for the heavier nuclei. Fits to the polarization reveal evidence for a spin-orbit coupling with radius and diffuseness different from those of the real central well, and the trend is for the spin-orbit diffuseness to be smaller rather than the radius. The symmetry of (N − Z)/A dependence of the potential may be ascribed either to the real well depth or to its radius; an average potential of both types is found which gives a good overall account of the data. (auth)

7795 ISOBARIC ANALOGUES OF STATES IN ^{90}Zr. Black, J. L. (Oxford Univ.); Islam, M. M.; Jones, G. A.; Morrison, G. C.; Taylor, R. B. Nucl. Phys., A92: 365-85(1967).

Isobaric analogue states in ^{90}Zr were studied using the reactions ^{89}Y(p,n)^{89}Zr (all neutrons detected), ^{89}Y(p,n)^{90m}Zr (decay product of isomeric state detected), ^{89}Y(p,γ$_0$)^{90}Zr, ^{89}Y(p,γ)^{90m}Zr (decay product of isomeric state detected), and ^{89}Y(p,p')^{89m}Y (decay product of isomeric state detected). It is shown that reaction cross-section measurements complement measurements on elastic scattering as a spectroscopic tool in that they are capable of revealing states of double excitation in the analogue nucleus. Comparison of the peak locations in the different reaction channels reveals energy shifts which have not yet been accounted for by theories of the reaction mechanism. (auth)

7796 STUDIES OF ^{165}Dy LEVEL SCHEME BY ANALYZING THE SPECTRUM OF CONVERSION ELECTRONS EMITTED FROM THERMAL NEUTRON CAPTURE. Bondarenko, V. A.; Prokof'ev, P. T.; Simonova, L. I. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 2168-72(Dec. 1965). (In Russian).

The ^{165}Dy nucleus was investigated by studying the internal-conversion electrons emitted during the (n,γ) reaction, using a magnetic β spectrometer and a Dy_2O_3 target. The system was calibrated on the basis of the known lines of the decay scheme ^{165}Dy → ^{165}Dy → ^{165}Ho. The error in the measurement of the intensities amounts to about 20%; below 100 keV the error was higher. It was found that the 83.5-keV transition occurs between the $\frac{9}{2}^+$ and the $\frac{7}{2}^+$ states of the rotation band of the $\frac{7}{2}^+$ ground state. The levels at about 600 keV were of special interest; the level population due to direct transitions from the captured state during the (n,γ) reaction indicates that these levels have $\frac{1}{2}$ or $\frac{3}{2}$ spins; the relatively weak excitation of these levels during the (d,p) reaction with respect to the (n,γ) reaction indicates that the state has a collective character. The 538.62-keV state passes into the ground state by a transition with a conversion coefficient corresponding to the E2 type. (TTT)

7797 EVIDENCE FOR THE SLOW-NEUTRON GAMMA-FISSION REACTION IN ^{238}Pu. Bowman, C. D. (Univ. of California, Livermore); Auchampaugh, G. F.; Stubbins, W. F.; Young, T. E.; Simpson, F. B.; Moore, M. S. Phys. Rev. Lett., 18: 15-17(Jan. 2, 1967). (UCRL-70069).

An analysis of the fission-width distribution for the lowest-energy slow-neutron resonances of ^{238}Pu was made. Values of the fission width were obtained from measurements of the fission and total cross sections. The results indicate that the (n,γf) reaction is present in ^{238}Pu. (D.C.W.)

7798 MEASUREMENT OF LIFETIMES UP TO ONE SECOND OF ISOMERIC NUCLEAR STATES POPULATED IN THE DECAY OF RADIOACTIVE SOURCES. Radeloff, J.; Buttler, N.; Kesternich, W.; Bodenstedt, E. (Univ., Bonn). Nucl. Instrum. Methods, 47: 109-15(1967).

The half life of the 1.1 sec isomeric state of ^{177}Hf populated in the decay of 155d ^{177m}Lu was measured by the coincidence technique. This measurement revealed some interesting new phenomena of the theory of accidental coincidences. They are described together with the experimental setup which was developed for this investigation. (auth)

7799 THE EXCITED STATES OF ^{107}Ag AND ^{109}Ag. Black, John L.; Gruhle, Wolfgang (Stanford Univ., Calif.). Nucl Phys., A93: 1-30(1967).

The decay schemes for the low-lying states of ^{107}Ag and ^{109}Ag were studied and revised. States of both nuclei were populated by Coulomb excitation with oxygen ions. The states of ^{107}Ag were also populated through the β^+ − EC decay of ^{107}Cd. De-excitation γ rays were studied with Ge(Li) detectors of active volume 5.6 cm^3 and 25 cm^3. The B(E2) values were extracted from the Coulomb excitation data. The proposed level schemes are discussed in terms of a vibrational model for ^{107}Ag and ^{109}Ag, in which it is assumed that most of the negative-parity states arise from the coupling of a $p_{\frac{1}{2}}$ proton to the vibrational states of the neighboring doubly even core nuclei. (auth)

7800 CONVERSION COEFFICIENTS AND PARTICLE PARAMETERS IN ^{207}Pb. Kleinheinz, P.; Vukanovic, R.; Samuelsson, L.; Krmpotic, D.; Lindstroem, H.; Siegbahn, K (Univ. of Uppsala). Nucl. Phys., A93: 63-73(1967). (UUIP-461).

The K-K, K-γ, γ-K, and γ-γ directional correlations were measured for the 1064-keV M4 − 570-keV E2 cascade in ^{207}Pb. From the results, the K-shell particle parameters for the two transitions were obtained with high accuracy. Experimental values for the total LM shell particle parameters are obtained from correlation measurements with LM electrons. The K-shell conversion coefficients for the two transitions were determined by a coincidence method. The results are in good or approximate agreement with the tabulated values. The γ-γ directional correlation results indicate a $9 \pm 5 \times 10^{-4}$ E5 admixture in the 1064-keV M4 transition. (auth)

7801 INTERNAL BREMSSTRAHLUNG FROM ^{32}P AND ^{210}Bi. Narasimha Murty, K.; Jnanananda, S. (Andhra Univ., Waltair, India). Nuovo Cimento (10), 46B: 217-36(Dec. 11, 1966).

The continuous spectra of internal bremsstrahlung from the beta decays of ^{32}P and ^{210}Bi were measured using a single-channel NaI(Tl) scintillation spectrometer along with a standard geometrical arrangement. Sufficient care was taken to avoid spurious effects, and corrections were made for several factors, such as background, energy resolution, backscattering, Compton and escape electrons, geometrical and gamma detection efficiency of the crystal, and absorption of the radiation between source and detector. Also the total yields of intensity and of energy of internal bremsstrahlung from each of the isotopes ^{32}P and ^{210}Bi in the energy regions investigated were determined and were compared with the corresponding theoretical values. The experimental results in the case of ^{32}P are compared in the energy region of 100 to 1200 keV with the allowed theory of Knipp and Uhlenbeck and of Bloch (KUB theory) and also with the Coulomb-corrected theory due to Lewis and Ford; and it is found that in the energy region from 100 to 600 keV there is a small but definite experimental excess of 15% over the KUB theory, while above 600 keV the experimental distribution coincides with the Lewis and Ford distribution. In the case of ^{210}Bi, the experimental results are compared in the energy range from 90 to 550 keV with

the KUB theory and also with the Coulomb-corrected theories of Lewis and Ford and of Nilsson. A fairly good agreement is obtained between the experimental distribution and the Nilsson theoretical distribution throughout the investigated energy region. (auth)

7802 THE SPECTRA OF INTERNAL BREMSSTRAHLUNG FROM THE BETA DECAY OF ^{90}Y AND ^{90}Sr. Bienlein, J. K.; Graf, G.; Kreische, W.; Lampert, W.; Loos, G. (Univ., Erlangen-Nuernberg, Ger.). Nucl. Phys., A92: 549-60(1967). (In German).

The spectra of internal bremsstrahlung from the beta decays of ^{90}Y and ^{90}Sr were measured absolutely with a scintillation spectrometer. The spectra are corrected for external bremsstrahlung, for efficiency in the NaI(Tl) crystal, for absorption in the crystal mounting, and for pile-up. The absolute beta activity was determined by measurements with a 4π-scintillator and by measurements with well defined geometry. The results are compared with theoretical calculations of Knipp, Uhlenbeck, and Bloch, of Lewis and Ford and of Felsner and Gebhardt. For ^{90}Y the results are for lower energies ($\leq$500 keV) in agreement with Knipp et al. For higher energies, they are better represented by Felsner and Gebhardt. For ^{90}Sr the results agree with Felsner and Gebhardt for lower energies ($\leq$200 keV). For higher energies they lie higher than those calculations. The beta decay of ^{90}Y $\rightarrow$ ^{90}Zr was observed over more than 16 half lives. The lifetime was found to be $T_{\frac{1}{2}}$ = 64.6 $\pm$ 0.8 h. (auth)

7803 SYSTEMATICS OF THE FISSION PROCESS PERTINENT TO NEUTRON AND GAMMA EMISSION. Wilets, Lawrence (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 9: 453 (Oct.-Nov. 1966).

7804 FISSION OF Tl, ^{206}Pb, ^{207}Pb, AND ^{208}Pb NUCLEI BY PHOTONS OVER AN ENERGY RANGE OF 100 TO 260 MeV. Ranyuk, Yu. N.; Sorokin, P. V. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 11: 1075-7(Oct. 1966). (In Ukrainian).

A 360-MeV linear electron accelerator was used to measure the photofission cross section of Tl, ^{206}Pb, ^{207}Pb, and ^{208}Pb nuclei. In the energy range investigated (100 to 260 MeV), an increase is observed in the photon energy cross section. The character of the energy dependences of the photofission cross sections of Tl and lead isotopes are the same as for other nuclei. The presence of closed nucleon shells in the target nucleus does not affect the value of photofission cross sections, while the dependence of the photoproduction cross sections on the mass number of the target nucleus does not differ from the known dependence on the parameter Z^2/A. (auth)

7805 ANGULAR DISTRIBUTION OF FRAGMENTS FROM ^{233}U PHOTOFISSION. Kulikova, N. M.; Nikitina, N. V.; Popov, N. V. Tr. Fiz. Inst., Akad. Nauk SSSR, 34: 183-6(1966). (In Russian).

The angular distributions of fission fragments from the photofission of ^{233}U and ^{238}U induced by x rays with a maximum energy of 12 MeV were measured. The observed isotropy in the angular distribution of fragments from the photofission of ^{233}U is in agreement with Bohr's predictions for the fission of odd-A nuclei. (D.C.W.)

7806 ANOMALOUS ELECTRIC DIPOLE INTERNAL CONVERSION. Hager, Ralph Stuart. Pasadena, Calif., California Inst. of Tech., 1966. 104p.

Thesis.

Electric dipole internal conversion was experimentally studied for several nuclei in the rare-earth region. Anomalies in the conversion process were interpreted in terms of nuclear structure effects. It was found that all the experimental results could be interpreted in terms of the $\mathbf{j}\cdot\mathbf{r}$ type of penetration matrix element; the $\mathbf{j}\cdot\nabla$ type of penetration matrix element was not important. The ratio λ of the E1 $\mathbf{j}\cdot\mathbf{r}$ penetration matrix element to the E1 gamma-ray matrix element was determined for ^{155}Gd, ^{177}Hf, ^{175}Lu, ^{169}Tm, and ^{182}W. Predictions for λ are made using the unified nuclear model. (Dissertation Abstr.)

7807 GAMMA-RAY SPECTROSCOPY AND COLLECTIVE EXCITATIONS IN ^{105}Rh AND ^{127}I. Neeson, John Francis. Buffalo, State Univ. of New York, 1965. 112p.

Thesis.

The low-lying level structure of ^{105}Rh and ^{127}I was studied using gamma-gamma coincidence measurements and directional correlation measurements. Radioactive sources were prepared by thermal neutron capture and the disintegrations of ^{105}Rh and ^{127}Te were studied using a fast-slow coincidence spectrometer. The theoretical treatment of the excited states of spherical nuclei was presented from both the de-Shalit and the Kisslinger and Sorenson points of view. More emphasis was given to the de-Shalit approach because of the more general applicability of its predictions to the isotopes under investigation. The decay of 4.4-hr ^{105}Ru to ^{105}Rh was studied. Gamma spectra and gamma-gamma coincidence measurements have shown that several new gamma transitions and weakly-fed levels exist in ^{105}Rh. A decay scheme is presented. Directional correlation measurements were made on the 315-470 keV, 485-470 keV, and 317-148 keV cascades in ^{105}Rh. The respective expansion coefficients were found to be $A_2 = -0.012 \pm 0.010$ and $A_4 = 0$; $A_2 = 0.079 \pm 0.019$ and $A_4 = 0.031 \pm 0.022$; $A_2 = 0.161 \pm 0.020$ and $A_4 = -0.036 \pm 0.023$. Spin assignments were made to the pertinent levels. Mixing ratios for the most probable spin sequences are presented for the transitions involved in the directional correlation measurements. Gamma transitions in the decay of 9.3-hr ^{127}Te to ^{127}I have been studied using fast-slow coincidence techniques. One new weakly-fed level was identified. Gamma-gamma directional correlation measurements were carried out on the 215-203 keV and 360-58 keV gamma-gamma cascades. Unique spin assignments were made on the basis of these directional correlation data and correlative evidence to the levels involved in these cascades. These spin sequences are $^5/_2 \rightarrow {}^3/_2 \rightarrow {}^5/_2$ and $^5/_2 \rightarrow {}^7/_2 \rightarrow {}^5/_2$ for the 215-203 keV and 360-58 keV cascades, respectively. Mixing ratios for the gamma transitions involved in the directional correlation measurements were tabulated. A comparison of the level structure of these two isotopes with the predictions of de-Shalit and with those of Kisslinger and Sorenson is presented. The more qualitative approach of de-Shalit has found application in the interpretation of the results for both isotopes. The more detailed approach of Kisslinger and Sorenson has not been applicable to the treatment of ^{105}Rh but was found to be very valuable in the discussion of the low-lying levels of ^{127}I. (Dissertation Abstr.)

7808 ENERGY LEVELS OF ^{156}Gd AS POPULATED BY BETA DECAY FROM ^{156}Eu AND ELECTRON CAPTURE FROM ^{156}Tb. Peek, Neal Frazier. Davis, Calif., Univ. of California, 1966. 65p.

Thesis.

The energy levels of ^{156}Gd were studied both from the decay of ^{156}Tb by electron capture and ^{156}Eu by beta decay. Sources for the ^{156}Eu decay were produced by a (3n,γ) reaction on ^{153}Eu in a flux of 4×10^{14} n's/cm^2/sec in the MTR reactor at Arco, Idaho. Sources for the ^{156}Tb decay were produced by a (p,n) reaction on ^{156}Gd using 10.5-MeV protons from the Davis 22-inch isochronous cyclotron. Ion column chemistry was necessary in order to separate the radioactive ^{156}Tb from the stable ^{156}Gd. Some of the theoretical predictions of the unified model of the nucleus are discussed and compared to the experiment. Measurements of internally and externally converted electrons were made with the Davis precision beta ray spectrometer and these results utilized along with gamma ray measurements to calculate multipolarities of transitions and level spins and parities. A decay scheme is presented which contains sixty transitions and twenty-five energy levels fed both by beta decay from ^{156}Eu and electron capture from ^{156}Tb. (Dissertation Abstr.)

7809 INTERNAL CONVERSION STUDIES IN DEFORMED NUCLEI. Brantley, William Henry. Nashville, Vanderbilt Univ., 1966. 78p.

Thesis.

Studies in nuclear spectroscopy were carried out using an iron-free, double-focusing, beta spectrometer and a magnetic-lens spectrometer. The decay scheme of ^{154}Eu was investigated, and L-subshell ratios of pure E2 transitions in five deformed nuclei were measured. The ^{154}Eu activity was produced by neutron capture and had about one percent ^{152}Eu contamination in it. The energies of transitions above 400 keV were carefully measured. Relative intensities of internal-conversion electrons were measured for 19 transitions (only 11 transitions have been reported earlier). Relative gamma intensities were also measured by the external-conversion method. By the internal-external conversion method, the conversion coefficients of the 593-, 678-, 682-, 694-, 725-, 758-, 999-, 1007-, and 1278-keV transitions were determined. By the use of coincidence techniques, the 694-keV transition was determined to be between the 0.187-MeV, 2+ level and the 0.123-MeV, 2+ level in ^{154}Gd. The multipolarity assignments of some of the transitions were determined on the basis of the measured conversion coefficients. For the 593-, 678, 682-, 694-, 725-, 758-, 999-, 1007-, and 1278-keV transitions the assignments are E1, E0 + E2, E0, E0 + E2, E1, E2, E2, E2, and E1, respectively. The 0+, and 2+, and 4+ members of the beta vibration band are definitely established. A revised decay scheme based on this work is presented. E0-E2 mixing in the 694-keV, 2+ $\rightarrow$ 2+ transition and in the 678-keV, 4+ $\rightarrow$ 4+ transition was measured and was found to be 5.1 $\pm$ 1.2% and >1%, respectively. In addition, relative B(E2) values were determined, and parameters Z_0 and Z_2, which give a measure of the mixing of the ground-state rotational band with the beta- and gamma-vibrational bands, were determined to be -0.06 ± 0.03. L-subshell ratios of pure E2, 2+ $\rightarrow$ 0+ transitions in the deformed-rare-earth region and the deformed-heavy-element region

were measured. The transitions studied in the rare-earth region were the 123-keV transition in ^{154}Gd, the 84-keV transition in ^{170}Yb, and the 100-keV transition in ^{182}W. In all cases the experimental L_2/L_3 ratios were found to agree with theory, but the L_1/L_2 and L_1/L_3 ratios did not agree with theory. The average of the experimental L_1/L_2 and L_1/L_3 ratios was found to be higher than the same average for the theoretical values by 17 ± 7% in ^{154}Gd, 16 ± 9% in ^{170}Yb, and 40 ± 20% in ^{182}W. To see whether these deviations might be enhanced in the deformed-heavy-element region, measurements of L-subshell ratios of the 42.9-keV transition in ^{240}Pu and the 57.9-keV transition in ^{228}Th were carried out. As in the case of the rare earths, the L_2/L_3 ratios agree with theory. In contrast to the case of the rare earths, the L_1/L_2 and L_1/L_3 values agreed with the values of Sliv and Band, but were 30% lower than those of Rose. The experimental results are discussed in the light of the disagreement for low energies between the two sets of theoretical values in this Z-region. (Dissertation Abstr.)

7810 EXPERIMENTAL STUDY OF THE TIME DEPENDENCE OF THE BETA ENERGY SPECTRUM FROM ^{235}U FISSION FRAGMENTS. Kutcher, James William. Urbana, Ill., Univ. of Illinois, 1966. 115p.

Thesis.

An absolute measurement was made of the time dependence of the beta energy spectrum from fission fragments. Specifically, the measurement concerned beta particles of energies greater than 0.75 MeV produced in the fission of ^{235}U by thermal neutrons from a reactor beam port. The time behavior of this beta spectrum was measured for four cases. The fission source was a foil coated with approximately 38 milligrams of ^{235}U and placed in the neutron beam from a tangential beam port of the University of Illinois TRIGA reactor. The fission rate was measured with an ionization chamber. The beta energy spectrum was measured with a plastic scintillator, with absolute counting being determined by the known solid angle between source and detector. Pulses from the scintillation counter were fed to a 100-channel analyzer which was gated by coincidences between the scintillation counter and a gas-flow, proportional, transmission counter placed between source and scintillator to signal the passage of an electron. Beta spectra were recorded for periods ranging from 5 seconds to 5 minutes, the length and frequency depending upon the rate of change of the spectra. Change was most rapid immediately following a change in the fission rate. The use of a magnetic tape unit permitted rapid storage of recorded data from an analyzer, allowing many spectra to be recorded in a short time. Background and dead time corrections, along with analysis of the experimental data, were performed using a digital computer. With a collimator system designed for this experiment, and with the coincidence gating of the analyzer, background was reduced to less than 10%. The total uncertainty in the analyzed data was less than 5% for the steady power runs and less than 8% for the reactor pulsing runs. Good agreement was obtained with previous experimental data for the equilibrium beta spectrum. The more important results of the experimental measurements can be summarized as follows. In the case of start-up at a constant fission rate, the high-energy portion of the beta spectrum soon reaches equilibrium, but the buildup is much more gradual at the low-energy end. In the case of shutdown after a period of fissioning at a constant rate, the entire spectrum gradually shifts downward in energy. The relative spectral change in the low-energy region compared to that in the high-energy region increases with increasing time after shutdown. The number of betas emitted at any time after shutdown from a three-hour run is higher than the number emitted at the corresponding time after a one-hour run. This effect is larger at longer times after shutdown. (Dissertation Abstr.)

7811 AN EVALUATION OF FISSION PRODUCT NEUTRON CAPTURE CROSS SECTIONS IN THE ENERGY RANGE 1 keV TO 10 MeV. Benzi, V.; Bortolani, M. V. (CNEN, Bologna). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/115, 18p. (CONF-661014-9). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The radiative capture cross sections of nuclei produced in the fission process are evaluated in the energy range 1 keV to 10 MeV by means of the statistical model formulas. Competition between capture and inelastic scattering is considered. In addition, the contribution due to the direct capture process is roughly estimated. Whenever possible, theoretical values are compared with the experimental ones. (auth)

7812 CHANNELLING EFFECTS IN THE ENERGY DEPENDENCE OF $\bar{\nu}$ FOR ^{235}U AND ^{232}Th. Prokhorova, L. I.; Smirenkin, G. N.; Shpak, D. L. (Inst. of Physics and Energetics, Obninsk, USSR). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/95, 16p. (In Russian). (CONF-661014-29). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The results of measurements of the relationship between the mean number of secondary neutrons $\bar{\nu}$ and the energy of the neutrons E_n inducing the fission of ^{235}U and ^{232}Th are given. Measurement of $\bar{\nu}$ was performed by the method consisting of selecting pulse coincidences from $^{10}BF_3$ counters in a paraffin block, inside of which was located a multilayer fission chamber. The neutron source was the T(p,n) reaction, obtained with a Van de Graaff accelerator. The measurements of $\bar{\nu}$ for ^{232}Th were performed in the neutron energy range from 1.6 to 3.2 MeV, and those of $\bar{\nu}$ for ^{235}U in the range from 0.4 to 3.2 MeV; the energy step was ~0.2 MeV and the energy resolution ~0.06 MeV. The accuracy of the $\bar{\nu}$ values was about 1% for ^{235}U and about 2% for ^{232}Th. The measured values for $\bar{\nu}$ were compared with those calculated from the mean kinetic energy of the fission fragments in the same energy range. In general, the measured dependence of $\bar{\nu}$ on the energy of the neutrons E_n inducing ^{235}U fission takes the form of a somewhat stepped curve. In particular, in the energy region from 1 to 2 MeV the slope $d\bar{\nu}/dE_n$ is 0.06 MeV^{-1}, whereas at higher neutron energies $d\bar{\nu}/dE_n$ ~0.15 MeV^{-1}. One of the possible explanations of the stepped dependence of $\bar{\nu}$ on the energy of neutrons inducing fission of the even-even compound nucleus ^{236}U could be the existence of an energy gap in the ^{236}U fission channel spectrum. The stepped form of the energy dependence of $\bar{\nu}$ is in good qualitative agreement with the conclusions of V. M. Strutinsky and V. A. Pavlinchuk regarding the effect of nucleon pairing on the internal excitation spectrum of fissionable nuclei. (auth)

7813 PROMPT $\bar{\nu}$ IN NEUTRON INDUCED FISSION OF ^{241}Pu. Conde, H.; Hansen, J.; Holmberg, M. (Research Inst. of National Defence, Stockholm). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/19, 8p. (CONF-661014-16). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The energy dependence of $\bar{\nu}$ prompt (the average number of prompt neutrons produced per fission) for the neutron-induced fission of ^{241}Pu has been investigated. The fission neutron detector was a large liquid scintillator. The data from 0.5 to 14.8 MeV of incident neutron energy can be fitted by a straight line $\bar{\nu}(E_n) = 2.905 + 0.146\ E_n$. (auth)

7814 DEPENDENCE OF THE SYMMETRICAL ^{238}U FISSION CROSS SECTION ON NEUTRON ENERGY. Borisova, N. I.; Dubrovina, S. M.; Novgorodtseva, V. I.; Pchelin, V. A.; Shigin, V. A.; Shubko, V. M. (Kurchatov Inst. of Atomic Energy, Moscow). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/113, 12p. (In Russian). (CONF-661014-10). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The yields of various products of symmetrical and asymmetrical ^{238}U fission were compared by radiochemical means. Fission was produced by monoenergetic neutrons. Measurements were made for neutron energies of 1.5, 2, 3, 4, 5, 13, 15, 16.5, and 18 MeV. The ratios of the product yields for symmetrical fission to those for asymmetrical fission at neutron energies of 2, 15, 13, and 18 MeV were 1/500, 1/90, 1/8, and 1/8 respectively. The experimental results are compared with those obtained from existing fission models. (auth)

7815 MEASUREMENT OF TOTAL NEUTRON CROSS SECTIONS OF THE ISOTOPE ^{230}Th IN THE 0.02 TO 50 eV ENERGY RANGE. Kalebin, S. M.; Ivanov, R. N.; Paley, P. N.; Karalova, Z. K.; Kukavadze, G. M.; Pyzhova, V. I.; Shibaeva, N. P.; Rukolaine, G. V. (Inst. of Theoretical and Experimental Physics, Moscow). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/104, 16p. (In Russian). (CONF-661014-24). DTIE.

From IAEA Conference on Nuclear Data, Paris.

A quantity of 105 mg of the isotope ^{230}Th was separated by chemical means in order to investigate the total neutron cross sections. To ensure reliable identification of neutron levels, the purity of the sample was established by mass-spectrometric analysis. The neutron cross-sections were measured on a mechanical chopper suspended in a magnetic field. In the energy region over which measurements were taken a number of levels were found for which some of the parameters are reported for the first time. (auth)

7816 RESONANCE LEVEL PARAMETERS FOR CADMIUM ISOTOPES. Adamchuk, Yu. V.; Danelyan, L. S.; Muradyan, G. V.; Schepkin, Yu. G. (Kurchatov Inst. of Atomic Energy, Moscow). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/108, 12p. (In Russian). (CONF-661014-7). DTIE.

From IAEA Conference on Nuclear Data, Paris.

A neutron time-of-flight spectrometer with a linear accelerator as neutron source was used to measure total neutron cross sections, capture cross-sections, and self-indication of the separated cadmium isotopes ^{111}Cd, ^{112}Cd, ^{113}Cd, and ^{114}Cd up to an energy of

about 1 keV. Level parameters were determined. The spin values were obtained for a number of even-odd isotope levels. The most probable values of the strength functions S_0 were calculated. (auth)

7817 STATISTICAL CALCULATION OF FISSION PRODUCT CROSS SECTIONS. Cook, J. L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/78, 12p. (CONF-661014-17). DTIE.

From IAEA Conference on Nuclear Data, Paris.

Theoretical methods are outlined for estimating average resonance parameters and group cross sections of fission products where experimental measurements are unavailable. The GUNYA sequence of programs, designed to generate group cross sections for use in reactor burnup calculations, is described. (auth)

Nuclear Theory

Refer also to abstracts 7456, 7478, 7687, 7688, 7694, 7701, 7711, 7725, 7730, and 7794.

7818 (BNL-9108(Suppl.)) ABSTRACTS OF COMPUTER CODES. (Brookhaven National Lab., Upton, N. Y.). 1966. Contract AT(30-2)-Gen-16. 23p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Abstracts (31) dealing with computer programs for the analysis of nuclear decay, reactions, scattering, spectra, and structure are presented. References are included with each abstract. (D.C.W.)

7819 (FEI-36) OPREDELENIE PLOTNOSTEI UROVNEI I PARAMETRA "A" IZ DANNYKH PO USREDNENNYM SECHENIYAM ZAKHVATA. (The Determination of the Level Density and of the "A" Parameter from the Data on Average Capture Cross Section). Kapchigashev, S. P.; Popov, Yu. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Tekhnicheskii Institut). 1966. 10p. (In Russian). Dep. mn.

The cross sections for the radiative capture of neutrons with energies of < 50 keV, averaged over numerous resonances, were analyzed to obtain the $\langle \Gamma_\gamma/D_0 \rangle$ parameters. From these parameters, using the radiation widths measured for separate resonances, the level densities for nuclei $51 \leq A \leq 205$ and also the values for the a parameter (the density of single-nucleon states near the Fermi surface) were calculated. The results coincide basically with the data obtained from the calculation of low level resonances. The general course of the $a(A)$ dependence agrees with the theoretical Abdel'malik and Stavinskii curve. (JPRS)

7820 (JINR-P10-2935) OPREDELENIE VEROYATNOSTI OSUSHCHESTVLENIYA KANALA YADERNOI REAKTSII. (Determination of the Probability of the Channel Realization of Nuclear Reaction). Moroz, V. I.; Nikitin, A. V.; Troyan, Yu. A.; Shakhbazyan, B. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 7p. (In Russian). Dep. mn.

The problem of separation of recorded events into nuclear reaction channels is considered. A general expression for the probability of the channel realization of nuclear reaction is derived by the maximum likelihood method. (auth)

7821 (MIT-2098-273) INTERMEDIATE STRUCTURE. Feshbach, H. (Massachusetts Inst. of Tech., Cambridge, Lab. for Nuclear Science). Sept. 1966. Contract AT(30-1)-2098. 23p. (CONF-660906-37). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From International Conference on Nuclear Physics, Gatlinburg, Tenn.

A summary is given of the phenomena of intermediate structure in nuclear reaction cross sections, which is analyzed in terms of an intermediate amplitude with resonances. These resonances are associated with doorway states. When the energy of the interacting system is close to that of the doorway state and if that state has a sufficiently small down width, an associated structure in the cross section can be expected. The procedure of separating out the important configurations from the complex states induced by the interaction is familiar in bound-state calculations, except that in the case of scattering the amplitude of the doorway state in the wavefunction can be quite small. (S.F.L.)

7822 (NP-16368) TOBIA: A FORTRAN PROGRAM FOR THE ANALYSIS OF NUCLEAR STRIPPING REACTIONS. Marini, A. (Milan Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Milan (Italy); Sansoni, M. (Milan Univ. (Italy). Istituto di Fisica). Oct. 1965. 62p. (IFUM-024/FT(RI)). Dep. mn.

A program for the numerical computation of the cross section and the polarization in (d,nucleon) stripping reactions in the case of capture of the nucleon in an $l = 0$ state is described. The expressions for $d\sigma(\theta)/d\Omega$ and P are evaluated in the distorted wave Born approximation, taking into account the spin-orbit distortions on the emitted nucleon as well as on the incident deuteron in the first perturbative order. The program is written in the FORTRAN IV language and was tested on the IBM 7040/32K computer of the Centro di Calcolo dell'Università di Milano. (auth)

7823 (ORNL-P-2570) OPTICAL MODEL AND INELASTIC SCATTERING. Satchler, G. R. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 28p. (CONF-660906-43). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Nuclear Physics, Gatlinburg, Tenn.

The situation on experimental data for use in optical-model analyses of elastic and inelastic scattering is summarized. It is concluded that microscopic analysis of inelastic scattering promises to be a powerful spectroscopic tool for checking nuclear wavefunctions. (S.F.L.)

7824 (ORNL-TM-1538) ENERGY PARAMETERS FOR LIGHT NUCLIDES IN MONTE CARLO NUCLEAR EVAPORATION PROGRAMS BASED ON EVAP. Peelle, R. W.; Aebersold, P. M. (Oak Ridge National Lab., Tenn.). Oct. 17, 1966. Contract W-7405-eng-26. 28p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The Monte Carlo nuclear evaporation system (EVAP) employed to estimate particle spectra and radiochemical yields following calculated intranuclear cascade reactions has been modified, largely to improve the energy parameters for nuclides lighter than sodium. Additional nuclear masses have been added to the mass table for light nuclides, and the Cameron mass function is employed to give the mass difference between the unknown mass and a nearby known one. Since these pairing corrections imply a nonphysical evaporation threshold, some trials employed a procedure which allowed further evaporation whenever this artificial threshold induced premature history termination. Nuclei that are unstable to particle emission are not allowed to be residual nuclei, and when a nominal residual nucleus is also one of the possible evaporated particles, it is included in the spectrum of that particle without any residual excitation. The kinetic energy of each recoil nucleus is accumulated, using the approximation that each evaporation is at 90° in its center-of-mass system. For nuclides having neutron or proton numbers less than 11, originally omitted correction parameters were included in the mass function for shell and pairing effects. Pairing energy corrections were similarly supplied in these cases for the level density estimation. The effects of these changes are discussed, with typical results used as illustrations. Except for the recoil calculation and the improved termination procedure, the changes had more impact on estimated radiochemical yields than on predicted particle spectra. Some radiochemical yield estimates were altered by a factor of more than 10. (auth)

7825 (ORNL-TM-1621) DISCRETE SAMPLES OF A CHI-SQUARED DISTRIBUTION WITH ONE, TWO, THREE, AND TEN DEGREES OF FREEDOM. Vondy, D. R. (Oak Ridge National Lab., Tenn.). Sept. 1966. Contract W-7405-eng-26. 24p. Dep. mn. CFSTI $2.00 cy, $0.50mn.

Finite sets of numbers representing relative magnitudes of a primary variable were obtained for chi-squared distributions with one, two, three, and ten degrees of freedom. (auth)

7826 NOTE ON THE COMMUTATOR METHOD FOR HINDERED NUCLEAR MATRIX ELEMENTS. Ichimura, Munetake (Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 36: 853-4(Oct. 1966).

Some questions on the use of effective transition operators for estimating hindered nuclear matrix elements are considered, and it is shown that the commutator method corresponds to a special type of perturbation. (L.B.S.)

7827 ISOTOPIC-SPIN EFFECTS IN ELASTIC SCATTERING. Nurzynski, J. (Australian National Univ., Canberra). Austral. J. Sci., 29: 93-6(Oct. 1966).

Some methods for measuring the isospin potential by observing elastic scattering are outlined, and some results are presented. (D.C.W.)

7828 QUASI PARTICLES AND EIGENVALUES OF LIPPMANN-SCHWINGER NUCLEI. Mueller, Harald J. W. (Univ., Munich). Z. Phys., 198: 132-47(1967). (In German).

Several properties of the eigenvalues of the Lippmann-Schwinger kernel for Yukawa-type potentials are investigated. In particular, the analogue of the Dashen-Frautschi formula, which was recently used for the calculation of the neutron-proton mass difference, is derived; and the result is extended to resonances. The eigenvalues of the Lippmann-Schwinger kernel are then used to obtain a necessary and sufficient condition for the quotient of two Jost functions (corresponding to distinct potentials V_1, V_2) to be the Jost function

corresponding to the difference of their potentials ($V_1 - V_2$). The result leads to separable potentials. Finally, the classical analogues of the vertex and wave-function renormalization constants are studied, and the relation between Weinberg's theory of quasiparticles and Bohr's compound model of the atomic nucleus is discussed. (auth)

7829 INTRODUCTION TO NUCLEAR MATTER. Day, Benjamin D. Argonne Nat. Lab. Rev., 3: 75-9(July 1966).

The description of nuclear matter is briefly discussed. The case of the noninteracting Fermi gas is considered first. The Brueckner-Goldstone theory is then discussed with emphasis on the two-body problem. The convergence of the Brueckner-Goldstone expansion for the ground-state energy is also considered. (D.C.W.)

7830 POTENTIAL SCATTERING OF NUCLEONS OF MEAN ENERGY BY NON-SPHERICAL NUCLEI. Rokhlenko, O. V. Ukr. Fiz. Zh., 11: 1167-71(Nov. 1966). (In Ukrainian).

In the adiabatic approximation with precision to within small values of the second order relative to the parameter of nonsphericity of the nucleus, the problem is reduced to that of scattering on some spherically symmetric potential; and a method for determining the potential is given. Inelastic scattering with excitation of the rotating levels of the nucleus proves to be a process of the second order. Expressions are obtained for the correction terms of the second order. An approximate Green's function is constructed for the spherically symmetric problem with the help of nonlocal separable potentials. (auth)

7831 MATERIALY XV EZHEGODNOGO SOVESHCHANIYA PO YADERNOI SPEKTROSKOPII I STRUKTURE ATOMNOGO YADRA, MINSK, 25 YANVARYA–2 FEVRALYA 1965. (Reports of the 15th Early Conference on Nuclear Spectroscopy and Nuclear Structure, Minsk, Jan. 25–Feb. 2, 1965). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 2130-2288(Dec. 1965). (CONF-650119(Vol.3)).

Separate abstracts were prepared for 7 of the 20 papers included, which deal with spectrometric studies and techniques. The application of spectrometric techniques to studies of nuclear structure is stressed. (D.C.W.)

For abstracts of individual papers see: 6230, 7788, 7789, 7796, 7832, 7835, and 7839.

7832 SOME PROPERTIES OF ODD NUCLEI IN THE TRANSITION REGION. Berlovich, E. E. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 2177-97(Dec. 1965). (In Russian).

The properties of the odd nuclei in the transition region depend primarily on the relation between the pair-formation forces which tend to render the shape of the nucleus spherical, and the polarization forces, acting from the unfilled-shell side and tending to deform the nucleus. The theoretical study of these nuclei is complicated by the fact that the adiabatic approximation cannot be used and the effect of pair-formation must be correctly evaluated. An examination of strongly deformed nuclei of rare-earth elements indicates that the properties of odd-proton nuclei, such as ^{147}Eu, ^{149}Eu, ^{145}Pm, ^{147}Pm, and ^{149}Pm, may be qualitatively explained by the Nilsson scheme, assuming the presence of small equilibrium deformations which increase slowly with increasing neutron number up to 88. A further increase of neutrons, to 90, results in a more marked deformation, accompanied by changes in the orbital of the unpaired proton. The observed data contradict the widely accepted transition from a spherical to an ellipsoidal shape of the nucleus in the transition region. It is conceivable that in the lower states of the odd-proton nuclei, the spherical and spheroidal shapes are superimposed, as was suggested by S. Hinds et al. for ^{150}Sm. (58 references.) (TTT)

7833 LEVEL DENSITIES OF EXCITED SYSTEMS WITH PAIRING INTERACTIONS. Nemeth, J. (Eoetvoes Univ., Budapest). Nucl. Phys., A92: 345-52(1967).

The energy and entropy of excited systems are determined with the help of the corrected BCS approximation. The level density is obtained for low temperatures as a function of the excitation energy and the energy gap. The level densities of even- and odd-mass systems are compared. (auth)

7834 STATES OF UNNATURAL PARITY AT THE FISSION THRESHOLD. Deenen, J.; Demeur, M. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 743-50(1966). (In French).

Octupole modes were included into the phenomenological description of collective levels in strongly deformed even nuclei. States with unnatural parity have been considered. The detection of these states by means of inelastic scattering with α particles and with ^{3}He particles is proposed. (auth)

7835 MOTION OF α-CLUSTERS IN HEAVY NUCLEI. Cherdantsev, P. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 2271-2(Dec. 1965). (In Russian).

The behavior of four interacting nucleons in a heavy nucleus, forming an α particle, was examined, assuming that the interaction involves the spherically symmetric Woods–Saxon potential. From this, the interaction of the four nucleons with the core of the nucleus may be derived by introducing Jacobi coordinates and solving the Schroedinger equation. A system of equations was obtained for a given level in the discrete function in order to determine the wave function of the relative motion. The matrix elements of the Hamiltonian of the collective motion of the α particle were then derived for the lowest excited state of the α particle, the ^{3}He + n or ^{3}He + p systems. The value of the excited state is very small. Assuming that the dimensions are normal near and outside of the boundaries of the nucleus, the α particle becomes "washed out" and does not exist as a cluster. The method may be used to study the state of clusters which pass through the boundaries of the nucleus. (TTT)

7836 SELF-CONSISTENT FIELD CALCULATIONS FOR THE NUCLEAR SURFACE AND ^{208}Pb. Koehler, H. S. (Rice Univ., Houston, Tex.). Nucl. Phys., A91: 593-603(1967).

Self-consistent field calculations were made for the nuclear surface (semi-infinite system) and for ^{208}Pb. A reaction matrix was calculated by the separation method from a spin-independent exponential nucleon potential interacting in S-states only. Only the dispersion (core) term and the long-range part were considered. By expanding the nonlocality of the reaction matrix an effective mass approximation is obtained. This simplifies the self-consistent field calculation considerably. Some parameters were adjusted to give proper saturation of the infinite system. The surface energy and surface thickness are calculated. Reasonable agreement with experiment is obtained, but both surface energy and thickness tend to be too large. Thus, the calculations give a Bethe–Weiszäcker parameter $a_2 \approx 27$ to 30 MeV and a surface thickness $\Delta S \approx 3.2$ fm. Experiments give $a_2 \approx 18$ to 26 MeV and $\Delta S \approx 2.4$ fm. In view of other calculations the discrepancy may be due partly to the too simplified interaction. However, softening of the core improves the agreement. Thus with no hard core $a_2 \approx 15$ MeV, $\Delta S \approx 2.0$ fm. The interior density of ^{208}Pb with Coulomb field is close to that of the infinite system with the same interaction. Without Coulomb field it is about 15% larger. (auth)

7837 EQUATIONS FOR GREEN FUNCTIONS OF FERMION SYSTEMS INCLUDING TWO-PARTICLE CORRELATIONS. Weigel, M. (Univ., Frankfurt am Main). Nuovo Cimento (10), 45B: 241-4(Oct. 11, 1966).

The application of Green functions in the treatment of many-particle systems is considered. Equations are derived for Green functions of fermion systems including two-particle correlations. (D.C.W.)

7838 SURFACE TENSION OF NUCLEAR MATTER. Knaak, S.; Suessmann, G.; Hilf, E.; Buettner, H. (Univ., Frankfurt am Main). Phys. Lett., 23: 711-13(Dec. 19, 1966).

The surface tension σ and the surface density thickness t of nuclear matter were calculated in the Fermi-gas model, the nucleons moving in a self-made shell model potential with a realistic slope and velocity dependence (parameters α and β). One gets the experimental values for σ and t with α and β agreeing with earlier data. (auth)

7839 POSSIBILITY OF DEVELOPING A SYSTEM OF DIRECTED NUCLEAR RADIATION. Varshalovich, D. A. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 29: 2173-6(Dec. 1965). (In Russian).

It is theoretically possible to develop a nuclear radiation system which acts like a radar reflector–director antenna; such a system could be based on excited nuclei as the active vibrators, and scattering nuclei as the passive ones. If the energy of the resonance level of the scattering nucleus is somewhat lower than the incident radiation ($\hbar\omega_0 < \hbar\omega$), the scatterer will behave as a reflector; in the opposite case when $\hbar\omega_0 > \hbar\omega$, it will act as a director, concentrating the radiation in a given direction. The incident and radiation-scattered radiations are always coherent. Interference of incident and scattered beams results in new angular distributions, the maxima and minima of which depend on the distance between the nuclei and the phase amplitude of the scattering, that is, on the shift of the resonance level. The shift may be achieved by using different chemical compounds, causing a mechanical deformation of the crystal, or by applying an inhomogeneous magnetic or electric field. Measurement of the angular distribution is a potential method for studying the structure of the emitting system or of the nuclear radiation itself. This scheme may be considered a variant of the Mössbauer experiment, allowing determination of the natural energy width of the γ line of the level shift, and the phase of the matrix element. The method is also suited for creating directed monochromatic γ rays. (TTT)

7840 NONLOCAL POTENTIAL BARRIER AND THE PEREY-EFFECT IN ALPHA DECAY. Bencze, Gy. (Univ. of Helsinki). Phys. Lett., 23: 713-15(Dec. 19, 1966).

It is shown that nonlocality in the alpha-nucleus potential increases the barrier penetrability. The range of nonlocality of the alpha-nucleus potential is estimated by comparing experimental and theoretical alpha decay rates. (auth)

7841 THEORETICAL INTERPRETATION OF EXCITED STATES OF DEFORMED LIGHT NUCLEI. Brihaye, C.; Demeur, M.; Reidemeister, G. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 739-42(1966). (In French).

An independent-particle model, at first proposed in order to describe quasimolecular states, gives qualitative information concerning most deformed excited states of light nuclei. These results were compared with experimental evidences and with other theoretical interpretations. The conclusion is that a 2^4-pole deformation has to be added to the well known ellipsoidal one. (auth)

7842 CORRELATIONS IN SOME SINGLE CLOSED SHELL NUCLEI. Miranda, A. (Univ. of Aarhus, Denmark). Nucl. Phys., A92: 386-400(1967).

The shell-model theory of ^{205}Pb is reexamined because of some unexplained discrepancies noted in previous calculations. The structure of its states below about 2.5-MeV excitation is also studied. It is found that a potential with a weak spin dependence and weak nonlocalities can describe well most of the states of ^{206}Pb and ^{205}Pb. This necessitates a large amount of configuration mixing. For states above roughly 2.5-MeV, excitations involving the N = 6 oscillator shell might be expected to play a role which may not be fully accountable with the model used here. It is found that only the lowest $\frac{1}{2}^-$, $\frac{3}{2}^-$, $\frac{5}{2}^-$ and, exceptionally, one of the higher $\frac{1}{2}^-$ excited states, have any appreciable seniority one content, when either local or nonlocal potentials are used. In general, large admixtures of states of seniority one and three are produced. The correlations in the ground state and the first excited state ($\frac{1}{2}^-$) can be accounted for by assuming that interaction takes place mostly in two-hole states with $J = 0^+$ and $J = 2^+$, in spite of the fact that $J = 0^+$ two-hole matrix elements turn out to be appreciably larger than others. For all the other calculated eigenstates of ^{205}Pb, the interaction in $J = 0^+$ and/or $J = 2^+$ two-hole states solely can not exhaust the correlations built in those eigenstates. (auth)

7843 POSSIBLE TEST FOR THE NUCLEAR SHELL MODEL AND THE IMPULSE APPROXIMATION. Devanathan, V. (Univ. of Virginia, Charlottesville). Nucl. Phys., 87: 477-80(1966). (ORO-2915-62).

A study is made of the polarization and angular distribution of the emitted nucleon in certain nuclear disintegration processes initiated by inelastic scattering or photoproduction of pions. The results can be used as a test of the nuclear shell model or alternatively of the validity of the impulse approximation. (auth)

7844 CORRECTIONS OF THE BCS APPROXIMATION IN THE CASE OF SYSTEMS WITH TWO UNPERTURBED LEVELS. Nemeth, J. (Eotvos Lorand Univ., Budapest). Nucl. Phys., A93: 223-31(1967).

The errors of the BCS approximation are examined in the case of a very simple system with two unperturbed levels. The ground-state energies of even and odd systems are determined with the quasi-spin formalism in a second-order perturbation calculation, and these values are compared with the results of the corrected BCS theory. The same procedure is applied to excited systems also. (auth)

7845 EIGENVALUES OF LIPPMANN-SCHWINGER KERNELS FOR YUKAWA AND NUCLEON-NUCLEON POTENTIALS. Mueller, Harald J. W. (Univ., Munich). Z. Phys., 198: 59-70(1967). (In German).

Simple high-energy asymptotic expansions for the solutions and eigenvalues of wave equations containing generalized superpositions of Yukawa potentials have been previously obtained. These investigations are extended to the calculation of phase shifts and eigenvalues of the Lippmann-Schwinger kernel. Corresponding Padé approximations are calculated, and by means of examples, their usefulness is demonstrated, even in regions of low energies. (auth)

7846 EFFECTIVE SINGLE PARTICLE STATES IN NUCLEAR REARRANGEMENT REACTIONS. Dolinszky, Tamas. Magyar Tud. Akad. Kozp. Fiz. Kut. Int. Kozlem., 14: 197-206 (1966). (In Hungarian).

Single-particle model states are introduced for rearrangement reactions which are analogous from the dynamical standpoint to given transitions of the reaction. Nonlocal one-particle potentials are derived for both the initial and the final channels. The scattering probabilities in either of these model problems reproduces the transition probability from the initial states to the final states in the physical problem. A system of coupled differential equations specifies the effective single-particle states, which may be also interpreted as the extension of the numerical "radial factors" of the R-matrix and the complex-pole theories from the channel entrance over the whole configuration space. (auth)

7847 APPROXIMATE ELECTRON RADIAL FUNCTIONS FOR BETA DECAY AND ANALYSIS OF ^{12}B AND ^{12}N SPECTRA. Huffaker, J. N.; Laird, C. E. (Univ. of Alabama, University). Nucl. Phys., A92: 584-92(1967).

Electron radial functions for a uniformly charged nucleus are approximated to order $(\alpha Z)^2$ and compared with point-charge-nucleus functions and tabulated "exact" functions. The accuracy and utility of these approximations is demonstrated with an analysis of ^{12}B and ^{12}N beta-decay spectra. It is suggested that some published tables of positon functions may be in error. (auth)

7848 PHASE-SHIFT ANALYSIS OF ELASTIC NUCLEON–DEUTERON SCATTERING. Van Oers, W. T. H. (Instituut voor Kernphysisch Onderzoek, Amsterdam. Univ. of California, Los Angeles); Brockman, K. W. Jr. Nucl. Phys., A92: 561-83(1967).

Using the approach of Christian and Gammel, a phase-shift analysis was performed on existing elastic nucleon–deuteron scattering data in the energy range 1 to 40 MeV. As contrasted with the previous work of Christian and Gammel, the lower order phase shifts were taken to be complex for incident nucleon energies above 3.3 MeV. To guarantee as much as possible a meaningful result, the deuteron total disintegration cross section was included in the calculations. Tensor and spin-orbit forces were ignored and therefore splitting of the phase shifts was not taken into account. The ^4S, ^2S, ^4P, and ^2P phase shifts found have a reasonable energy dependence; for decreasing energy they converge to the results of Christian and Gammel. (auth)

7849 TRIPLE ANGULAR CORRELATION CONTOUR PLOTS FOR THE (p,$\gamma\gamma$) REACTIONS. Taras, P.; Azuma, R. E. (Univ. of Toronto, Can.). Nucl. Instrum. Methods, 47: 116-20(1967).

Triple angular correlation contour plots have been computed for a number of spin sequences between entrance channel spin $\frac{1}{2}$ and spin of the final state $\frac{1}{2}$, $\frac{3}{2}$, $\frac{5}{2}$ for the reaction (p,$\gamma\gamma$) in two different geometries. The effect of finite counter solid angle was taken into account. In all, 81 such contour plots were obtained. Two examples of these contour plots are shown. (auth)

7850 VARIATIONAL STUDIES OF THE FEW-BODY NUCLEUS. Aranoff, Sanford. New York, New York Univ., 1965. 100p.

Thesis.

A model triton was studied. The model consists of three bodies interacting via a two-body central gaussian potential. A type of polarized gaussian wave function was used in a minimal principle for the energy. This polarized function gives significantly lower energy than the unpolarized wave function. It also has the advantages of simplicity and generality. The binding energy compares very well with an exact numerical solution of the problem, as well as the energy obtained by other means. Similar results were obtained for the alpha particle. A three-body potential can be written down in various ways so that the wave function is an exact solution of the Hamiltonian formed by adding this potential to the original Hamiltonian. One way of considering this function is in coordinate space. A simple function was found to approximate this in regions where the wave function is not small. It has the form of a gaussian times a quadratic expression. Another way is by using projection operators. This was used for the following calculations. An upper bound for the mean square radius was calculated. This involved an extension of the ideas of a previous calculation of an upper bound for the kinetic energy of two electrons. A variational principle for quantities other than the energy was set up. This theory was applied to the mean square radius. (Dissertation Abstr.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 5747, 5986, 6131, 6253, 6797, 6857, 6869, 7629, 7666, 7694, 8030, 8089–8091, 8117, and 8118.

7851 (AAEC-E-147) GYMEA: A NUCLIDE DEPLETION, SPACE INDEPENDENT, MULTIGROUP NEUTRON DIFFUSION, DATA PREPARATION CODE. Pollard, J. P.; Robinson, G. S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar. 1966. 138p. Dep. mn.

GYMEA is a multi-purpose neutronics code used extensively in the H.T.G.C.R. project of the A.A.E.C. The code has three main functions: running of burnup surveys of near-homogeneous reactor systems; running of neutron diffusion calculations in nuclear data library correlations with measurements made in near-homogeneous subcritical assemblies; and preparation of suitably averaged cross section data from the code's 120-group (with resonance parameters), 70-nuclide main data library for direct input to space-dependent codes such as CRAM, 4-ZOOM (9-ZOOM translated to the IBM 7040), DSN and TDC (Carlson's FLOCO versions translated to the IBM 7040), and WDSN. Because free input is used and a toy compiler is provided, new applications of the code can be developed by code users to extend its function. The source language is FORTRAN IV (95 per cent) and MAP (5 per cent) for the IBM 7040 (and later an IBM 360). 32K words of core storage are required together with 4 to 6 magnetic tapes and an on-line 1401 including reader, punch, and printer. Typical runs for data preparation take 3 minutes, diffusion calculations 10 minutes, and burnup calculations 15 minutes. A few illustrative examples are included in the report. (auth)

7852 (ACNP-64509) EXTERNAL COLLAPSING PRESSURE FOR ELK RIVER REACTOR FUEL ELEMENT TUBING. (Allis-Chalmers Mfg. Co., Washington, D. C. Atomic Energy Div.). Jan. 1964. Contract AT(11-1)-654. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The ability of the Elk River Reactor (ERR) fuel element cladding tubes to withstand external operating and hydrostatic test pressures is described. Theoretical and experimental investigations of the strength capabilities of the tubing under external pressures were performed and the results are presented. Tension tests were performed on samples of the tubing used in the ERR fuel elements to determine the material yield strength and ultimate strength. Collapse tests were also run on tubing samples at 600°F and 70°F. The lowest and average collapsing test pressures at 600°F were 1800 psi and 2010 psi and at 70°F, 2400 psi and 2750 psi. A computer analysis of the maximum allowable external pressure the tubing could withstand was performed using a computer code based on elastic theory and which considers tube ovality. Analysis to determine the tubing critical buckling pressure was performed. The ERR fuel element tubes may be subjected to external pressures up to 1250 psig maximum during reactor operation with an associated temperature up to 600°F. During hydrostatic testing of the reactor system, the fuel element tubes may be subjected to external pressures up to approximately 1375 psig at temperatures below 200°F. (auth)

7853 (AD-635088) RADIATION DAMAGE IN SOLIDS: COMPILATION OF ABSTRACTS. Andrushis, J.; Shishkevish, C. (Library of Congress, Washington, D. C., Aerospace Technology Div.). Apr. 18, 1966. 194p. (ATD-66-43; TT-66-61659). CFSTI $5.00 cy, $1.00 mn.

Radiation damage to semiconductors, metals and alloys, polymers, low-molecular-weight compounds, lubricants, ceramics, alkali halides, ruby, calcium fluoride, Rochelle salt, quartz, glycine sulfate, devices and components, and insulating materials is covered in this compilation. (auth)

7854 (ANL-7189) THE ROLE OF THE ADJOINT FLUX IN DETERMINING REACTOR STABILITY. Jason, Richard Harry (Argonne National Lab., Ill.). Mar. 1966. Contract W-31-109-eng-38. 95p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Thesis. Submitted to Purdue Univ., Lafayette, Ind.

The conditions required for the boundedness and stability of the output of a reactor system for the situation in which the reactor properties are explicit functions of space and power level are determined. This nonlinear problem was investigated by using the methods of time-dependent perturbation theory as applied in quantum mechanics. A condition on the perturbation matrix was found which is sufficient to insure boundedness in the large of the neutron flux and reaction rates such as power density. This condition yields to equivalent conditions on the adjoint flux. Since the latter obeys a linear equation, it is simpler to study its behavior as an indicator of the boundedness of the reactor system. The reactor system is described by a one-dimensional, multigroup, time-dependent, diffusion-theory model. (J.C.W.)

7855 (ANL-7201) EBR-II FUEL-UNLOADING MACHINE: DESIGN AND PERFORMANCE CHARACTERISTICS. Hutter, E.; Elias, P.; Veith, D. J.; Ware, W. R. (Argonne National Lab., Ill.). June 1966. Contract W-31-109-eng-38. 91p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The fuel-unloading machine forms the link between the fuel-handling mechanisms inside the sodium-filled primary tank and the interbuilding coffin. The machine consists of a self-propelled shielding cask, which moves between the primary-tank transfer port and the interbuilding-coffin pit. A gripper mechanism can be extended through the cask shielding valve to grip the fuel subassembly and pull it into, or lower it out of, the shielding cask. An automatic argon-circulating system provides cooling, heating, and sodium blow-off capabilities. The electrical control is interlocked with the fuel-handling control systems. The fuel-handling system, the design features of the fuel-unloading machine, and the operation of the system are described. (auth)

7856 (ANL-7255) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, SEPTEMBER 1966. (Argonne National Lab., Ill.). Oct. 26, 1966. Contract W-31-109-eng-38. 101p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Summaries of progress are presented concerning the EBWR Pu recycle program, EBR-II operation and development, physics experiments in ZPR-3 and ZPPR, burnup measurements for fast reactors, Na technology, fuel development and processing, reactor physics development, fuels and cladding development and fabrication, heat transfer and fluid flow studies, mechanics of materials studies, fluoride volatility process development, liquid metal direct conversion generator research, AARR design and development, and research on nuclear safety. (J.R.D.)

7857 (APDA-195) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, JUNE 15–SEPTEMBER 15, 1966. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 86p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An investigation of Na–water reactions from small leaks is being conducted to determine mechanisms of reactor tube wastage from this cause. During the report period data and information were gathered on target-tube temperatures and surface effects from Na–water reactions. In other work, testing was initiated in a steel reaction vessel to determine target metal surface temperature as function of target–leak spacing and water leak rate. Test results are presented from Na technology loop operation on response of rhometers and O_2 meters to NaO injections in the loop and cold traps. Development work on Na scanner includes demonstration of an A-scan mode for scanning narrow-beam transducers. Compilation of Fermi experience was continued. Assistance was given PNL on design of the Fast Flux Test Facility. (J.R.D.)

7858 (BAW-393-7) EVALUATION OF THORIUM FUELS FOR THE HEAVY WATER ORGANIC COOLED REACTOR. (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). July 1966. Contract AT(38-1)-393. 235p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

ThO_2 fuels are evaluated for the Heavy Water Organic Cooled Reactor (HWOCR). The long-range objective of the Th fuel cycle development is the proof of performance of Th fuel elements in an HWOCR environment. The types of fuel elements studied were Th metal nested cylinders, ThO_2 clustered pins, and ThC clustered pins. The economics and fuel utilization of the three fuel element types were evaluated for use in HWOCR. Technical feasibility and development costs were considered in the selection process. A test program was planned in conjunction with the optimization studies. On the basis of the comparative evaluation it is recommended that both the oxide and the metal fuel elements be carried through several phases of irradiation testing before a final selection is made. Priority should be given to the development of the ThO_2 fuel element. (auth)

7859 (BMI-1777) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report for July–September 1966. Morrison, David L.; Genco, Joseph M.; Gieseke, James A.; Ritzman, Robert L.; Wal-

ters, Craig T.; Wooton, Roger O. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1966. Contract W-7405-eng-92. 29p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The study is restricted to pressurized-water and boiling-water reactors where the maximum credible accident is considered to be loss of coolant. Work during the quarter includes efforts devoted to modification of FLASH blowdown program for use with other accident analytical models and investigations of instabilities in heat transfer calculations using NURLOC. Work toward development of Post-blowdown fluid-flow models is reported. Reactor flow channels are described using equations to represent values related to conservation of mass, momentum, and energy. Descriptions of plug flow in the reactor thermal-shield area are included. Estimates of fission product release in core meltdown are discussed along with mathematical models of fission product diffusion. A well-mixed model analysis was applied to the pressure-vessel plenum chamber and blowdown line to provide time-dependent fission-product release information. Results of studies concerning transport and deposition of charged aerosols are presented along with analyses of particle charging mechanisms. (J.R.D.)

7860 (BMI-1787) INVESTIGATION OF TRITIUM GENERATION AND RELEASE IN PM NUCLEAR POWER PLANTS. Ray, Joseph W.; Wooton, Roger O.; Barnes, Russell H. (Battelle Memorial Inst., Columbus, Ohio). Oct. 31, 1966. Contract W-7405-eng-92. 121p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Investigation revealed the ternary fission process to be the major source of tritium. The triton fission fragments are generated at the rate of approximately 8.7×10^{-5} tritons per fission with an apparent Gaussian energy distribution about a most probable energy of 7.5 to 9 MeV. The resultant tritium migrates to the reactor primary coolant by diffusion from the fuel elements, and is transported to various plant locations in the coolant water. PM water samples were assayed for tritium by a liquid-scintillation technique. A mathematical model describing tritium generation and movement throughout PM plants was developed. The resulting digital computer program, TRICON, was employed to calculate tritium concentrations at PM-3A during 1965; agreement between calculated and measured concentrations was good. Potential radiological health hazards from both airborne and waterborne tritium activities were calculated. The most economical solution at PM-1 appears to be the arrangement with an outside contractor to remove tritiated effluent from the plant site. At PM-3A the most economical solution appears to be the expelling of tritiated effluent water to an isolated area where it will freeze and sublime to the atmosphere in safe concentrations. (auth)

7861 (BMI-X-10180) HEAT-RESISTANT CONCRETE FOR PRESTRESSED-CONCRETE-PRESSURE-VESSEL (PCPV) REACTORS. Quarterly Progress Report, July–September 1966. Fondriest, F. Frederick; Snyder, M. Jack (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1966. Contract W-7405-eng-92. 8p. (EURAEC-1748). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Work on the establishment of realistic temperature limitations for structural-grade concrete and the determination of means to extend the limitations by modification of the concrete is reported. The first phase was initiated: the experimental work was planned, the concrete compositions were chosen, and the necessary materials and equipment were selected. Plans for future work are outlined. (M.H.R.)

7862 (BNWL-SA-286) ^{146}Pm CONTENT IN HIGHLY IRRADIATED POWER REACTOR FUELS. Roberts, F. P.; Van Tuyl, H. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 29, 1965. Contract AT(45-1)-1830. 14p. (CONF-650902–18). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Chemical Society 150th National Meeting, Atlantic City, N. J.

Four samples of fuel from the Yankee pressurized water reactor and three from the Vallecitos Boiling Water Reactor (VBWR) were analyzed radiochemically to determine the isotopic purity of the fission product PmO. Burnups were 13,700 to 31,800 MWd/T of U for the Yankee fuel and 6540 to 17,400 MWd/T of U for the VBWR. Total quantities of a number of other potentially valuable fission products and transuranium isotopes were also determined. The maximum ratio of ^{146}Pm to ^{147}Pm found in the Yankee Reactor was 4.7×10^{-8} on a curie basis. There was little variation between samples representing widely different reactor exposure; the ^{146}Pm/^{147}Pm ratio evidently reaches an equilibrium value at rather low exposures. The data obtained should relieve apprehensions concerning long-term availability of high quality (low gamma dose rate) Pm for isotopic heat source applications. Pm sources containing 4 ppm ^{146}Pm will require no more shielding than ^{238}Pu for many applications. The fuel from the VBWR contained less ^{146}Pm per curie of ^{147}Pm than the Yankee samples. (auth)

7863 (CEA-R-3021) CONTRIBUTION A L'ETUDE DE LA DESORPTION DES GAZ DE FISSION FORMES DANS L'OXYDE D'URANIUM IRRADIE. (Contribution to the Study of the Desorption of Fission Gases Formed in Irradiated Uranium Oxide). Berry, Jean-Louis; Darras, Raymond; Roger, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1966. 24p. (In French). Dep. mn.

The release of ^{133}Xe from irradiated UO_2 has been studied in the temperature range 1300 to 1900°C, using various monocrystalline or sintered samples. Up to 1600°C, this release is proportional to the square root of the time and thus occurs essentially by diffusion. The apparent diffusion constant D′ decreases and the activation energy of the corresponding process increases as the integrated neutron flux received by the fuel increases. As the density of the sintered samples decreases however, the activation energy of the release also decreases, so that the difference between D′ values for sintered samples of different densities decreases as the temperature rises. Finally, above 1600°C, the fission gas release phenomenon is governed by UO_2 evaporation, and all the different types of oxide studied have similar behaviors, characterized by poor retention of these gases. (auth)

7864 (CVNA–266) CVTR VAPOR CONTAINER LEAK RATE TEST, SEPTEMBER 1966. Barrow, W. E. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). Nov. 18, 1966. Contract AT(30-1)-2289. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The CVTR vapor container leak test was carried out as a safeguard against the remote possibility of an accidental release of fission gas products. A gas tight containment vessel is provided housing the reactor core and high temperature heavy water systems. The integral leak rate test was performed at 13 psig for a period of 3 days. Outline of the test details, changes in instrumentation from the last test and test results are included in this report. (J.C.W.)

7865 (EUR-3119.e) FISSION PRODUCT CHAINS AND THEIR IMPORTANCE ON HIGH BURN-UP FUEL CYCLES. Devos, J. J.; Massimo, L. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). July 7, 1966. 46p. Dep. mn.

The inaccuracies introduced by errors in the fission yields and by simplifications of the fission product chains are assessed. The effect of neglecting minor fission product chains and of grouping some of the fission products into aggregates is also discussed. (auth)

7866 (GA–7017) ICON-4: A PROGRAM FOR THE AUTOMATIC CONTOUR PLOTTING OF GAMBLE-4 GROUPWISE FLUXES AND POWER DISTRIBUTION. Smith, C. V. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). May 15, 1966. Contract AT(04-3)-167. 29p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

ICON–4 is an IBM 7044 program for automatic contour plotting of GAMBLE–4. GAMBLE–4 is a program for the solution of multigroup neutron-diffusion equations in two dimensions with arbitrary group scattering. Two special tapes from GAMBLE–4 are read by ICON–4 and plotted as input. Input is read to specify contour maps which are given. (J.C.W.)

7867 (GA–7232) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR POSTCONSTRUCTION RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending April 30, 1966. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 20, 1966. Contract AT(04-3)-314. 51p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The measurement program connected with loading and low-power testing was completed during the quarter. The analysis performed in connection with this program included calculations of the predicted properties of the reactor and preliminary reduction of the data obtained. Measurements made on just-critical and fully loaded 40-Mw(e) HTGR core included control rod reactivity worth, neutron flux distributions, and shutdown margins. Tests were also made to determine He pressure and flow effects on reactivity. Measurements were made of fuel element purge rates. (J.R.D.)

7868 (GA–7318) EXPERIMENTAL BERYLLIUM OXIDE REACTOR PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1966. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 29, 1966. Contract AT(04-3)-187. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Phase II testing of the control rod positioning motor speed reducer was terminated after failure of the bearings in the planetary gear train. Employment of a more substantial gear system is being considered. A topical report on the proposed Phase II control rod drive test program is being compiled. Investigations are being made to determine the activation of the pressure vessel and the

dose rate resulting from zero power testing. This information is necessary should seal-welding of the vessel flange be required. Further removal of the oil contaminant in the pressure vessel and associated piping continued by flushing the system with standard odorless paint thinner. The system was then sealed and dried by pumping-down with vacuum pumps. After drying operations were completed, the pressure vessel top head was removed and the vessel was found to be generally clean with some foreign matter appearing inside the vessel. Other EBOR systems are functioning properly. (J.R.D.)

7869 (GAMD–6928) KULAID: A COMPUTER PROGRAM USED IN THE DESIGN OF A COOLING SYSTEM FOR A CONCRETE REACTOR VESSEL. Ludwig, D. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Mar. 7, 1966. Contract AT(04-3)-167. 110p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

KULAID is a FORTRAN-IV computer code written for the IBM-7044 digital computer, and used as an aid in the analysis and design of a cooling system for a concrete reactor vessel. It carries out two main functions. First, using a one-dimensional model, it performs the heat transfer calculations necessary to determine the proper spacing of the cooling tubes attached to the concrete vessel liner. Second, it calculates the total cost of the entire vessel cooling system. (auth)

7870 (GAMD–6992) CONTROL STUDIES WITH AN ANALOG COMPUTER FOR THE STEAM GENERATOR IN A HTGR PLANT. Bachmann, U. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 15, 1966. Contract AT(04-3)-633. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A linear model of a high-temperature gas-cooled reactor plant was established and simulated on an analog computer. Only one loop of the primary coolant system and steam generator was simulated. The studies included the establishment of a reference control scheme and evaluation of reference controller settings. The steam pressure controller manipulating the feedwater flow with turbine flow as load index and the main steam temperature controller adjusting He flow with a feedforward from the feedwater flow are the same as proposed for HTGR plants. The third control loop maintaining reheat steam temperature was simplified by only using reheat steam temperature and turbine flow to get the reactor power set-point. The use of hot He temperature as a cascaded controlled variable in this loop proved to be disadvantageous. The value of turbine and feedwater flow as feedforwards and their action was investigated. The anticipatory signal to the helium flow setpoint proved to be the most important one and is necessary for good system stability at part load. Signals proportional to the variable providing the load index seem to be best suited for control purposes. All studies were made at 25% of rated steam flow. The studies had to be terminated before completion, as the analog computer was no longer available. (auth)

7871 (GAMD–7213) LINEAR ANALYSIS OF XENON INSTABILITY IN HIGH-TEMPERATURE GAS-COOLED REACTORS. Dahlberg, R. C.; Mangan, D. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 29, 1966. Contracts AT(04-3)-167; AT(04-3)-633. 26p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Specific power at which HTGR becomes unstable with respect to Xe oscillations is computed as a function of the thermal group infinite multiplication constant, the hardness of the thermal spectrum, reactor size and degree of flux flattening. Problems of Xe instability exist in 1000 MW(e) HTGR's. Stability margin may not be large if flux flattening in the radial direction is achieved. The Colorado reactor appears stable against Xe instabilities. The stabilizing effect of the temperature coefficient can be significant for coefficients as negative as -4×10^{-5}/°C in the operating range. The current analysis has been used successfully to analyze Xe transients in the Hanford and Savannah River reactors. The current analysis checks with the GAZED calculations. (J.C.W.)

7872 (GAMD–7230) NULL REACTIVITY MEASUREMENTS OF MULTIPLICATION CHARACTERISTICS FOR HIGH-TEMPERATURE, GAS-COOLED REACTOR CORES IN THE MODIFIED HTGR CRITICAL FACILITY. Nichols, P. F. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Aug. 23, 1966. Contract AT(04-3)-167. 36p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Measurements of the multiplication characteristics for HTGR were made in the modified HTGR critical facility. The method of measurement involves experimental determination of the physical constituents of a unit cell with a multiplication factor of one when it is in a spectral environment characteristic of an infinite array of cells of the same type. The unit cell then has required poison added and the calculations of the poisoned cell compared with unity. These measurements are valuable for core samples with multiplication factors at nearly unity in the absence of poison. (J.C.W.)

7873 (GAMD–7248) TAP: A FORTRAN IV PROGRAM FOR THE TRANSIENT ANALYSIS OF THE HTGR POWERPLANT PERFORMANCE. Savery, C. W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 12, 1966. Contracts AT(04-3)-167; AT(04-3)-633. 219p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Code development has continued for three and one half years. The ESADA, BROOKWOOD, and PSC versions of the HTGR have been successively modeled. Continuous code development has been necessary to keep pace with the evolution of the HTGR design. The version described contains the model of the current PSC plant design. The code has been utilized for the validation of powerplant process control schemes, the generation of temperature, flow and pressure histories for design and safeguards engineering, and the provision of transient information for use in equipment selection and plant operation strategy. Approximately 30 different transient problems including both normal and abnormal operating conditions have been simulated to date with TAP. The emphasis in this report is upon the operation of the code. A functional description is included as well as detailed operating instructions. A list of nomenclature and the source program listing are included. (auth)

7874 (GEAP–3898) FUEL CYCLE PROGRAM. A BOILING WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report No. 6, October 1961–December 1961. Hodde, J. A. (comp.) (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 31, 1962. Contract AT(04-3)-189. 66p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Calibration data on three previously described (GEAP-3781) instrumented fuel assemblies are presented. Stability tests made on the VBWR to provide a basis for analytical prediction of boiling reactor performance are described. Stability test runs with varied operating conditions were conducted using instrumented fuel elements. Fuel assembly irradiations in VBWR are described and their status summarized. A theoretical analysis of coolant channel burnout in forced convection with bulk boiling was completed. Calculations of the expected isotopic compositions based on wire irradiations in fuel assemblies indicate that Pu isotopes up to ^{241}Pu can be measured at 400 MWd/t and that ^{242}Pu can be measured after 1200 MWd/t. (J.R.D.)

7875 (GEAP–4406) AEC FUEL CYCLE PROGRAM. ASSEMBLY 1L: DESIGN AND FABRICATION OF FUEL RODS FOR PERFORMANCE DEMONSTRATION AT HIGH THERMAL RATINGS. Hoffmann, J. P.; Rous, W. C.; Williamson, H. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). May 1965. Contract AT(04-3)-189. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A Vallecitos Boiling Water Reactor (VBWR) test assembly was designed to operate UO_2 fuel rods with melting of the central portion of the fuel. The effect operation at such a condition has on fuel life was to be determined by irradiation testing. Based on design calculations, it was expected that central melting would just begin at a heat flux of 149 W/cm^2, and that 35 percent of the fuel pellet diameter would be melted at the peak design operating condition, 167 W/cm^2. Two fuel enrichments were used so that the fuel rods would operate with differing amounts of center melting. The fabrication process is described, and pre-irradiation data on the fuel and cladding properties and dimensions also are documented. The fuel assembly, designated 1L, was placed in the VBWR, and irradiation began in June 1961. The irradiation was to continue until an average burnup of at least 2.74×10^{20} fissions/cc of uranium dioxide (10,000 MWd/TU) had been achieved, or the rods failed. Destructive examinations of fuel rods were to be performed at regular intervals throughout life. Initially, it was intended to operate three VBWR assemblies at thermal conditions high enough to result in melting of the central portion of the UO_2 fuel. However, because of uncertainties in the reactor physics calculations and in the thermal conductivity of UO_2 at the time the assembly was designed, it was decided to irradiate only one of the three assemblies as a "calibration test," to confirm whether or not central melting of the UO_2 would occur. Examination of a fuel rod after calibration test operation at the peak design heat flux of 167 W/cm^2 indicated that the fuel had not melted. Subsequent burnup analyses indicated that the peak heat flux achieved was 154 W/cm^2, which was within the estimated accuracy of the reactor physics calculations, ±10 percent. This test indicated that to achieve UO_2 central melting, the fuel rod must be operated at a higher thermal rating, or, for the same surface heat flux, the diameter must be increased. Inasmuch as the calibration test had been made almost at the surface heat flux limit allowed in the VBWR, it was decided to conduct the second calibration run with a

larger diameter rod. In this test, a significant amount of UO_2 central melting occurred in a 3.492 centimeter o.d., stainless steel clad fuel rod. The thermal performance of Assembly 1L, about 66 W/cm (20 kW/ft), was sufficiently higher than that of current commercial fuel operating conditions that its irradiation was continued even though UO_2 central melting was not expected. (auth)

7876 (GEAP–4471) CALCULATED NUCLEAR REACTOR PARAMETERS AND THEIR UNCERTAINTIES IN A 1000 MWe FAST CERAMIC REACTOR. Greebler, P.; Cowan, C. L.; Gyorey, G. L.; Hutchins, B. A.; Fies, C. L.; Sueoka, J. R. (General Electric Co., San Jose, Calif. Advanced Products Operation). July 1966. Contract AT(04-3)-189. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Nuclear reactor parameters calculated for a 1000 MWe fast ceramic reactor in a design study are presented. An extensive survey was carried out to identify those uncertainties in nuclear data and calculational methods which are expected to have significant effects on the calculated reactor parameters. The effects of these uncertainties on safety and economic parameters are calculated using a simplified model of the reactor. The results show that favorable or unfavorable combinations of the uncertainties strongly influence the core design, and result in large differences in the safety and economic parameters. However, integral critical experiments tend to indicate that compensating errors occur and that the computed safety and economic parameters are probably accurate enough to form a reasonable basis for the evaluation of fast reactor designs. Some of the common assumptions used in cross section averaging are shown to have only a small effect on reactor design. (auth)

7877 (GEAP–4920) CREEP COLLAPSE TESTING OF ADVANCED EVESR FUEL CAPSULES. Eitler, P.; Hoffman, R. B. (General Electric Co., San Jose, Calif. Vallecitos Atomic Lab.). Aug. 1965. Contract AT(04-3)-189. 41p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The creep collapse behavior of fuel capsules exposed to superheat conditions of 1200°F and 1000 psi was investigated. Both pellet and powder fuel capsules with Incoloy-800, Type-2 cladding of various wall thicknesses were tested for 500 to 600 hours. All the pellet fuel capsules showed significant clad deformation. Almost no deformation was observed in the powder fuel capsules. (auth)

7878 (GEAP–5192) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Quarterly Progress Report No. 5, April–June 1966. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Aug. 1966. Contract AT(04-3)-189. 65p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method of data accumulation and display to facilitate determining paths to failure of selected reactor pipe components is presented. The path to failure traces the very special case of a component in which a failure occurs. Computer code development has centered on running check analyses using the enlarged PAPA program. The runs made used curved and flat rectangular elements and reflected the increased capacity of the program. As a result of continued debugging, code check-out has proceeded at a reduced rate. Test results indicate that the fracture toughness of low-C steels can be determined with adequate accuracy by any of several tests. The Charpy test and the test based on the Manjoine specimen yielded equivalent results, provided precautions were taken to eliminate plastic deformation in the Charpy specimens. To be of value, fracture toughness tests on pipe must be made with specimens from pipe walls, which practically limits the approximate size to that of the Charpy bar. Measurements were made of cyclic crack growth at room temperature in wide plates of A-212B and $2\frac{1}{4}$ Cr–1 Mo steels under conditions of superposed mean stress instead of the zero to maximum loading previously tested. For an identical maximum stress, a lower crack growth rate was observed. Calculations were made of the possible effects of loading rate and hold time on crack growth rates in elevated temperature testing. The results suggest that at 500 to 650°F full aging is rapid. The results of the analysis of the room temperature fatigue tests of edge-notched flat-plates yield preliminary stress and strain concentration factors and fatigue strength reduction factors for the three piping grades: plain C steel, $2\frac{1}{4}$ Cr–1 Mo, and type-304 stainless steel. (J.R.D.)

7879 (GEAP–5269) EVESR NUCLEAR SUPERHEAT FUEL DEVELOPMENT PROJECT. Quarterly Report No. 17, June–August 1966. (General Electric Co., San Jose, Calif. Advanced Products Operation). Sept. 1966. Contract AT(04-3)-189. 76p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The EVESR continued to operate in support of fuel development programs with a plant availability of 74%. A time operating efficiency of 45% was attained during the quarter in spite of an 8-day maintenance outage and two scheduled outages for fuel bundle changes. Following reactor startup, a survey of steam coolant radioactivity from all 32 fuel bundles in EVESR confirmed that significant fission product release is occurring only from the known defect in Mark II fuel bundle KB-29 and the deliberately defected Mark III fuel rod in bundle KB-41-1. A fifth Mark III fuel bundle was installed during the quarter for irradiation in EVESR. The EVESR operating license changes requested previously on behalf of the fuel development program were approved by the ACRS during the report quarter. The changes will permit fuel testing under more severe conditions. A new task was initiated during the report period to plan and prepare for shipping the irradiated EVESR fuel to the recovery plant following the final planned period of EVESR operation in January 1967. The post-irradiation examinations of the ruptured fuel rod from Mark II fuel bundle KB-11 and from Mark III fuel bundle KB-40 were completed. The annular Mark II fuel rod from KB-11 appears to have ruptured as a result of a waterlogging. The 0.012-inch-thick cladding on the Mark III fuel rod appears to have failed as the result of excessive stress at elevated temperature. The failure was probably the result of strain cycle fatigue. (J.R.D.)

7880 (IA-1082, pp 217-34) NUCLEAR SAFETY. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

Various studies on nuclear safety and the computation of environmental hazards resulting from a hypothetical reactor accident are summarized. The majority of the studies presented concern the calculation of radiation doses as a function of distance from the release point for various atmospheric conditions. (H.D.R.)

7881 (KAPL-M-6576) TWO MODE KINETICS EQUATIONS. Mathews, R. L. (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 1966. Contract W-31-109-eng-52. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A derivation of the two mode reactor kinetic equations is given and how the Perturbation Study Program (PSP) edits may be used to yield the required reactivity components is shown. (auth)

7882 (KAPL-M-SR-1(Rev.A)) RKC: REACTOR KINETICS CALCULATIONS PROGRAM. Fruhauf, C. L. (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 1966. Contract W-31-109-eng-52. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

RKC computes reactor startup transients in the range of reactor power levels where the temperature coefficient effect can be neglected. A constant shim rate and/or a time dependent table is used as a driving function. The code solves the space independent, one energy group reactor kinetics equations with a maximum of six delayed neutron groups. The kinetics equations are programmed in two forms: the first neglects the normalized reactor prompt generation time, τ_0; the second considers it. The arbitrary value of reactivity below which τ_0 is to be neglected is an input quantity. (auth)

7883 (LA–3561) SYSTEM DYNAMICS STUDY FOR THE ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT. Demuth, H. B.; Duerre, K. H.; Schilling, F. P.; Stiles, C. E. (Los Alamos Scientific Lab., N. Mex.). Aug. 30, 1966. Contract W-7405-eng-36. 260p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A study of the Ultra High Temperature Reactor Experiment (UHTREX) system dynamics is described. A mathematical model of the system is developed and investigated with various digital computer programs. The results show that the UHTREX system can be operated safely at design conditions and over a wide range of off-design conditions. The system is stable and relatively insensitive to inaccuracies and changes in heat transfer coefficients. A startup route and a hot restart procedure for the UHTREX reactor are studied and found to be satisfactory. A variety of hypothetical system failures are investigated. It is shown that the overall system is safe from damage even in the event of serious equipment failures. (auth)

7884 (NAA-SR-11995) PIQUA NUCLEAR POWER FACILITY REACTOR OPERATIONS ANALYSIS PROGRAM SEMIANNUAL PROGRESS REPORT NO. 7, JULY 1, 1965–JANUARY 13, 1966. DeBear, W. S.; Fukushima, T. Y.; Hansen, A. I.; Perret, J. D.; Roecker, J. H.; Shepard, R. C.; Tondi, D. (Atomics International, Canoga Park, Calif.). Oct. 25, 1966. Contract AT-11-1-GEN-8. 80p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The reactor continued to operate during the start of the current report period with one of the two main pumps shut down to reduce flow and thereby minimize the in-vessel filter pressure drop. One pump operation continued uninterrupted until July 18, 1965, when the reactor was shutdown for modifications, maintenance, and in-vessel filter replacement. Reactor startup was initiated September 6, and after preliminary warmup and testing, power operation was initiated. On October 10, one outer ring control rod was intentionally dropped into the core to determine the effect of its insertion and withdrawal on channel coolant outlet temperature. Increasing channel coolant outlet temperature in conjunction with a superheater leak necessitated reactor shutdown October 12. During the

shutdown, fuel shuffling was accomplished which increased the core loading from 67 to 70 fuel elements. The reactor was made critical on October 23, and power operation was resumed on October 24. On October 26, the position indicator coil for Control Rod No. 11 failed. Loss of the position indicator necessitated the full insertion and deenergization of this rod. Operation was then uninterrupted until November 24, when it became necessary to shut the reactor down to permit repair of tube failures in the condenser of the decay heat removal system. Reactor operation resumed after 13 hr. The reactor operated continuously throughout the month of December and into January with problems in the control rod electrical circuitry continuing. On January 13, the reactor scrammed from a spurious low degasifier level signal. The original switch failed because of excessive exposure to external heat. After corrective action had been taken by installing a new switch and after temporarily repairing control rod electrical circuitry prestartup tests were made which indicated the necessity for an extensive repair program before reactor operation. (J.R.D.)

7885 (NAA-SR-12175) AEC UNCLASSIFIED PROGRAMS. Quarterly Technical Progress Report, July–September 1966. (Atomics International, Canoga Park, Calif.). Nov. 25, 1966. Contract AT(11-1)-Gen-8. 173p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: stability and properties of cladding and structural alloys in a high temperature, liquid metal, fast neutron environment; boiling studies for sodium reactor safety; fast spectrum Doppler measurements; Na component development; sodium reactor experiment operation; Piqua development; reactor physics; reactor fuels and materials; high temperature reactor fuels and materials; Na chemistry; reactor safety; fission product and contamination control; characterization of Na fires and fission product release; high temperature and radiation chemistry; electronic structure of metals and alloys; and radiation damage in crystalline solids. (P.C.H.)

7886 (NAA-SR-Memo–12209) HALLAM NUCLEAR POWER FACILITY RETIREMENT PLAN, REVISION 4, OCTOBER 10, 1966. (Atomics International, Canoga Park, Calif.). Oct. 28, 1966. Contract AT(11-1)-Gen-8. 36p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The HNPF site is to be placed in such a condition that no AEC license would be required from a health and safety standpoint. The AEC directives, criteria, scope of work, and administrative controls toward this goal are given. (D.L.C.)

7887 (NAA-SR-Memo–12224) ASSESSMENT OF THE SODIUM REACTOR EXPERIMENT RELIABILITY. Glasgow, L. E. (Atomics International, Canoga Park, Calif.). Oct. 31, 1966. Contract AT(11-1)-Gen-8. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The design history of the SRE is discussed briefly. During the Power Expansion Program (PEP) initiated in Feb. 1964, the SRE was converted into a routinely operable test facility, with emphasis on improved plant reliability. The improvements in the moderator cells, heat exchanger, pumps, and instrumentation during PEP are described. (D.L.C.)

7888 (NAA-SR-Memo–12247) STORAGE OF MODERATOR ELEMENTS IN HNPF MODERATOR STORAGE CELLS. Schlapp, F. W. (Atomics International, Canoga Park, Calif.). Nov. 28, 1966. Contract AT(11-1)-Gen-8. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The long-term effects on the local groundwater radioactivity levels, if the radioactivity in the three stored HNPF moderator elements were released to the groundwater system, were calculated. Groundwater was assumed to come in contact with, and start dissolving the activated stainless steel portions of the three irradiated moderator elements now stored in the HNPF moderator storage cells. The solubility and decomposition rates of the metal and the concentration of radioactivity releasable to the groundwater were analyzed. The results showed that insignificant concentrations of radioactive materials can be released. (auth)

7889 (NP–16408) NUCLEAR POWER STATIONS THROUGHOUT THE WORLD. A Report Compiled on Questionnaire Survey Results. (Japan Atomic Industrial Forum, Inc., Tokyo). Dec. 1966. 82p. Dep. mn.

A survey was made of 80 reactors to be used for commercial purposes except for the Communist nations which did not answer the questionnaire. The survey devotes research items mainly to the study on the problems related to contract methods, sites, construction, operational control, and financing. The information is summarized and presented in this report. It is the intent that experiences be exchanged internationally. (J.C.W.)

7890 (ORNL-P–2531) PRELIMINARY RESULTS OF DIFFUSION MEMBRANE STUDIES FOR THE SEPARATION OF NOBLE GASES FROM REACTOR ACCIDENT ATMOSPHERES. Blumkin, S.; Briggs, H.; Dounoucos, A.; Von Halle, E.; Holmes, J. M.; Rainey, R. H. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 24p. (CONF-660904–13). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 9th Air Cleaning Conference, Boston.

The removal of Kr and Xe from off-gas streams during reactor emergencies and normal chemical reprocessing is studied. A thin silicone-rubber membrane that has attractive selective permeability properties for the rare gases and can be operated at ambient temperature is used for the study. A diffusion cascade has been designed to reduce the Kr level over a given period and a portable system to serve in emergencies for several reactors is proposed. The cascade design was based on the separation of radioactive and stable Kr from air since this is a difficult separation. Xe separation is efficient since the permeation rate of Xe through the membrane is higher than for Kr. (J.C.W.)

7891 (ORNL-P–2534) MOLTEN SALT REACTORS. Lane, J. A. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 26p. (CONF-660934–2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA International Survey Course on Economic and Technical Aspects of Nuclear Power, Vienna, Austria.

A breeder reactor technically feasible, economical as competing systems, and meeting the fissile material needs of nuclear economy so that mining of high cost ^{235}U becomes unnecessary has been the criteria for justification of the construction of the Molten Salt Reactor Experiment. The fuel in the MSRE is in the form of UF_4 dissolved in a mixture of LiF, BeF_2 and ZrF_4. The mixture is circulated by a pump through holes in the graphite core and delivers its energy through a heat exchanger located outside the core. Fear has been associated with pumping and circulating highly radioactive fuel solutions. The MSRE was built to prove that this problem may be solved by demonstrating the operability of salt reactors and also investigating the compatibility of fuels and materials in a high radiation field. The design, operation, and basic economics are reported. The Molten Salt Breeder Reactor is a scaling up design of MSRE and as such gives only a partial indication of the ultimate potential of molten salt reactors. (J.C.W.)

7892 (ORNL-P–2536) PHILIPPINE SPECIAL FUND PROJECT. AN ILLUSTRATION OF A FEASIBILITY STUDY. Lane, J. A. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 18p. (CONF-660934–4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA International Survey Course on Economic and Technical Aspects of Nuclear Power, Vienna, Austria.

The market for power in Luzon in the Phillipines was investigated. A study shows that future power needs will warrant a consideration for nuclear power plants. Power needs in the future will be supplied by imported fuels. In addition, the project included training of Phillipine scientists and engineers, survey of possible nuclear plant sites, and the preparation of draft legislation covering the acquisition and regulation of future nuclear installations. (J.C.W.)

7893 (ORNL-P–2668) VELOCITY MEASUREMENTS FOR BEDS OF LARGE, UNIFORM-DIAMETER SPHERES PACKED IN A FULL-SCALE MODEL OF A PEBBLE-BED NUCLEAR REACTOR. Bundy, R. D.; Hoffman, H. W. (Oak Ridge National Lab., Tenn.). [1962]. Contract W-7405-eng-26. 19p. (CONF-661001–33). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

Velocity profiles were obtained for shallow beds of randomly packed spheres to provide information needed in the hot-spot analyses of pebble-bed nuclear reactors. A nuclear reactor bed may be quite shallow, have a complicated bottom geometry, be topped by fill cones resulting from fuel recycling, and contain rather large spherical fuel elements. Mean radial velocity profiles reported were partially contradictory. Although most published data were presented as circumferentially averaged velocities, some incomplete results suggested the existence of large circumferential (angular) velocity variations at any given radius. These combined factors motivated the present experimental determination of radial and angular velocity distributions in a specific reactor configuration. (auth)

7894 (ORNL-TM–911) MSRE DESIGN AND OPERATIONS REPORT. PART XI. TEST PROGRAM. Guymon, R. H.; Haubenreich, P. N.; Engel, J. R. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 91p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A summary of design, development, and test plans for the MSRE are presented. Programs are outlined for investigation of fuel salt

reactions with graphite and container materials, and investigations related to reactor engineering and physics. Plans are also outlined for nonnuclear testing, zero-power experiments, low-power measurements, and reactor capability evaluation. (J.R.D.)

7895 (ORNL-TM-1566) CRITICALITY OF LATTICES OF HEAT TRANSFER REACTOR EXPERIMENT FUEL ELEMENTS. Johnson, E. B.; Reedy, R. K. Jr. (Oak Ridge National Lab., Tenn.). July 20, 1966. Contract W-7405-eng-26. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A series of experiments were completed to determine the critical parameters of lattices of HTRE fuel elements, primarily in geometries and environments of interest for transport, storage, and chemical dissolution. Arrays of these elements were made critical with water and with dilute aqueous $UO_2(NO_3)_2$ solution of two concentrations (to simulate dissolver environments) as moderator and reflector; one solution concentration was 3.97 g of ^{235}U/l and the other was 8.02 g/l. In some of the slab lattices in water, sheets of cadmium were placed between rows to serve as a neutron absorber as they might in a shipping container. (auth)

7896 (ORNL-TM-1677) IN-PLACE IODINE FILTER TESTS AT THE HIGH FLUX ISOTOPE REACTOR. Swanks, J. H. (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A series of in-place I_2 filter tests were performed on the charcoal I_2 filters at the High Flux Isotope Reactor. The results of those tests indicated that the originally-installed ½ in. activated charcoal filters were unsatisfactory. However, the newly-installed 1⅛ in. impregnated activated charcoal filters perform very satisfactorily. The efficiencies of the new filters are greater than 99.99% for elemental I_2 retention and 99.9% for methyl iodide retention. (auth)

7897 (STL-372-30) KINETIC STUDIES OF HETEROGENEOUS WATER REACTORS. Annual Summary Report, 1965. (TRW Systems, Redondo Beach, Calif. Physical Electronics Lab.). Dec. 30, 1965. Contract AT(04-3)-372. 112p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Work is reported on transient steam-void growth using fission-heated discs immersed in water inside capsules placed in the reflector of the KEWB transient test reactor. Results show that rapid transient boiling in highly subcooled water is a dynamic process involving the inertial motion of the loading water away from or towards the heated surface. The effects of inertial loading, subcooling, and ambient pressure on transient boiling processes were investigated. The characteristics of particular interest are the maximum rate of growth, maximum extent of the steam void volume, the magnitude of the initial pressure pulse, and the impulse given to the inertial load during the initial nucleate boiling phase. A number of comparison runs were made using an adiabatic temperature rise of about 450°C with a 12-msec risetime (5 msec reactor period). A review of the circumstances of the destructive pressure pulse in SPERT ID is presented. An explanation of this destructive pressure pulse involves mechanisms which trigger the dispersal of the molten-core Al into the core water. Mechanisms for pressurization of the approximately 12 l of void volume present in the core when the destructive pressure pulse occurred are not known. Results of experiments on pressure generation in water-filled fixed-volume capsules by thermal transients in solid surfaces to well above the 374°C water critical temperature are described. A description of pressure amplification in steam-water mixtures is applied to the SPERT ID destructive pressure pulse. Pressure amplification occurs when a moderate driving pressure collapses the last bubble in a steam-water mixture to produce a water-hammer impact pressure pulse. A shock tube experiment is described in which a moving water column impacts on liquid Al in vacuum and the resulting pressure and dispersal of the Al are observed. The pressure generation process observed in the shock tube experiment appears able to account for the SPERT ID delayed destructive pressure pulse. The major effort on reactor stability studies was the completion of surveys of the published models of hydrodynamic instability. The various models were analyzed to find their fundamental differences, and those with fundamental differences were programmed for a digital computer. The predictions of these models were then compared with the available experimental data. A high-pressure loop that was constructed for the measurement of power-void transfer functions in sub-cooled boiling in the power reactor range of operating conditions is described. The loop is designed for the investigation of subcooled boiling only. Void fraction measurement is by soft x-ray-attenuation, and analog cross-correlation techniques are used for transfer function measurement. The initial transfer function measurements are presented. (J.R.D.)

7898 (SWRI-1228P4-25) EVALUATION OF THE SERVICEABILITY OF THE ELK RIVER REACTOR PRESSURE VESSEL. Quarterly Report, July 1, 1966–September 30, 1966. Lautzenheiser, C. E.; Norris, E. B. (Southwest Research Inst., San Antonio, Tex.). Oct. 25, 1966. Contract AT(11-1)-1228. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A program to determine the effects of neutrons on the nil-ductility transition temperature and fatigue of pressure vessel steels for ERR is described. Specimens of A-302-B, A 105-II, and A-212-B steels were radiation tested. Data are included on Charpy V-notch testing. (J.R.D.)

7899 (UNC-5137) FAST REACTOR MIXED CARBIDE FUEL ELEMENT DEVELOPMENT. THE DESIGN AND FABRICATION OF THREE (UPu)C PILOT EXPERIMENTS FOR EBR-II. Cihi, J.; Hurwitz, S.; Rosh, D.; Strasser, A. (United Nuclear Corp., Elmsford, N. Y.). Oct. 25, 1965. Contract AT(30-1)-3415. 70p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Research development of pelletized solid solution (U,Pu)C fuel elements for fast breeder reactors is reported. The design and fabrication of three pilot rods to be tested in the EBR-II are described. Irradiation conditions to be encountered are outlined. (M.O.W.)

7900 (WANL-TME-1526) VARI-QUIR III: INCLUSION OF THE R-θ GEOMETRY. Collier, George; Riese, J. W.; Gray, W. H. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Oct. 1966. Contract SNP-1. 82p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Appendix A by W. H. Gray.

The new version of VARI-QUIR III permits the calculation of R-θ geometries with periodic boundary conditions. Also, the new code has complete variable dimensions at execution time. (auth)

7901 (WCAP-3269-17) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Progress Report, January 1–March 31, 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-3269. 42p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on development of nuclear instrumentation. Information is included on design and performance of long ionization chamber installations at the CVTR. A description of an instrumentation system recommended for use with large pressurized water reactors is presented. Fabrication and design of cores for large closed-cycle water reactors are summarized. Data and information are included on Zircaloy hydriding, proof testing fuel assembly prototypes, in-pile testing of defected fuel rods, experiments on Saxton high power density elements, fuel swelling, fuel enrichment, core flux homogeneity, canless fuel assembly design, and control rod performance evaluation. (J.R.D.)

7902 DOUNREAY FAST REACTOR MODIFICATIONS. Phillips, J. L. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Nucl. Eng., 12: 40-3(Jan. 1967).

The discharge is described of over 500 outer breeder elements which were distorted so as to be incapable of removal by the normal method. Details are given of the methods and equipment used in the operation and of the radiation and contamination conditions. The effect of the removal of considerable regions of the outer breeder elements on future reactor operation is considered. The distortion of the elements is stated to have been due to unexpected thermal cycling of the uranium through the 660°C phase transition temperature. (UK)

7903 REACTIVITY LOSS RESULTING FROM BURN-UP IN THE DOUNREAY FAST REACTOR. Macdonald, J. J. C. (Atomic Energy Establishment, Winfrith, Eng.). Nucl. Eng., 12: 43-4 (Jan. 1967).

The various contributions to the reactivity loss are calculated and the assumptions and simplifications are pointed out. Estimates of the errors involved and a comparison with the observed rate of reactivity loss are made. (UK)

7904 NUMERICAL REVOLUTIONS COUNTER FOR A REACTOR: AN APPLICATION OF LOGARITHMIC CALCULATIONS BY DIRECT METHOD. Combet, M.; Eder, J.; Van Zonneveld, H. H. (EURATOM, Ispra, Italy). Onde Elec., 1244-50(Nov. 1966).

The period of a reactor is measured by the use of an input signal logarithmically proportional to the neutron flux within the reactor. When the input signal of the cycle is applied in the form of pulses which are counted in a neutron counter it is logical to make the measurement by a numerical process. This system has the advantage of a higher reliability, a higher accuracy, a longer equivalent life, a simplification of control, and of operation, and the fact that the results can be directly dealt with numerically and that the system is insensitive to disturbances. (auth)

7905 MODERN TURBINE DESIGNS FOR WATER-COOLED REACTORS. Baily, F. G.; Miller, E. H. Nucl. Eng., 12: 29-32(Jan. 1967).

The low pressures and lack of superheating of the steam provided by water-cooled reactors require turbines designed for large volume flows, resistant to moisture damage, and with efficient moisture extracting devices. The application of reheat and non-reheat cycles is discussed. The selection of materials and the design of turbine buckets, moisture separators, and steam reheaters are reviewed. Design information for the turbines supplied, or on order, for power stations is summarized. (UK)

7906 NUCLEAR ENERGY AND THE GENERATION OF POWER. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). Nucl. Energy, 221-6(Sept.-Oct. 1966).

The development of nuclear power in the United States is reviewed and projections of its future growth are discussed. The role of the United States in international cooperation for the development of nuclear energy through the sharing of nuclear technology and nuclear materials is examined. (H.D.R.)

7907 CIRCULATIONS ON A REACTOR WITH A CIRCULATING FUEL OF VARIABLE DENSITY. Novikov, V. M. At. Energ. (USSR), 20: 520-2(June 1966). (In Russian).

The use of fuel in the gas or liquid phase in a nuclear reactor has several advantages over solid fuels. UF_6 is the only U compound which is in the liquid state at the temperature of 50°C. The density of UF_6 strongly depends on temperature. In this connection, the problem of calculating a reactor with a variable-density circulating fuel is basically nonlinear and its solution is complex. The critical reactor dimensions can be calculated approximately using conventional formulas with the fuel density being averaged in respect to the reactor core. The reactor criticality conditions are described by the expression: $\int_{\omega_0}^{\omega}(\omega-\omega_0)\kappa^2(\omega)d\omega \geq 0$, where $\kappa^2(\omega)$ is the Laplacian, corresponding to the fuel density with the specific enthalpy ω. The error in calculating the critical reactor dimensions using averaged density does not exceed 1% if the following condition is satisfied: $3(\rho_0-\rho_1/2\rho_1)\cdot(2-k_0/k_0-1) \leq 1$, where ρ_0 is the initial density of the fuel, and ρ_1 is the final density of the fuel. Since the variation in the density of UF_6 with an increase in the enthalpy is less pronounced than in case of an ideal gas, the above conditions can be regarded as a general criterion for using the approximation of the average fuel density. (ATD)

7908 NEUTRONIC ASPECTS OF A 1000-MW(e) GAS-COOLED FAST REACTOR. Broido, Jeffrey H. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 580-1(Oct.-Nov. 1966).

7909 ZONED FUEL CORE FOR A SODIUM-COOLED FAST REACTOR. Mahna, Kashmiri L.; Nims, John B.; Page, Earl M. (Atomic Power Development Associates, Inc., Detroit, Mich.). Trans. Amer. Nucl. Soc., 9: 581-2(Oct.-Nov. 1966).

7910 ANALYTICAL METHODS USED IN THE PRELIMINARY ANALYSIS OF THE TRANSIENT BEHAVIOR OF THE HWOCR. Coppersmith, W. C.; Harding, R. S.; Hencey, T. R. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc., 9: 461-2(Oct.-Nov. 1966).

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7981 URANIUM NEEDS AND URANIUM MARKETING ARRANGEMENTS. Kobusch, Bert. Glueckauf, 102: 792-7 (1966). (In German).

The probability of satisfying future needs for U is discussed on the basis of probable development of reactor capacities through 1980. A comparison of the probable energy needs with proposed reactor development shows that known U sources are not sufficient. The effects on the cost of U are considered. The factors and agreements controlling the U market are discussed. (J.S.R.)

7982 HOW NEW DESIGNS IMPROVE TURBINES FOR NUCLEAR PLANTS. Sinton, Walter (Westinghouse Electric Corp., Philadelphia). Power Eng., 70: 45-7(June 1966).

Some steam turbines designed for application with water-cooled reactor plants are described. A resume of applicable thermal cycles is included, and moisture removal devices are reviewed. A moisture separator–reheater combined in a single shell is shown. A list of large nuclear turbines designed for operation with dry and saturated steam shows that all domestic applications to date have been single-shaft 1800-rpm units. Factors influencing the decision to utilize 1800 rather than 3600-rpm elements are discussed. A description of a 650-MW, 3000-rpm, tandem-compound 4-casing turbine with sextuple 33.5-in. last row blades is included. (TCO)

7983 METHOD EMPLOYED FOR THE OPTIMALIZATION OF A CENTRAL POWER REACTOR OF 250 MW(e) (PROJECT UoS). Rognon, J. (EPUL, Wuerenlingen, Switzerland). Neue Tech., 8: 299-308(Oct. 1966). (In French).

Minimization of energy costs for a 250 MW(e) nuclear power plant is investigated. A complete parametric price function study cannot be undertaken because of the amount of computation required. Therefore, the value of each minimum cost parameter has been calculated using MINICH, a program which searches for the minimum cost by taking successive steps along a decreasing gradient. A previous version of this program has been adapted for this study. In testing the procedure, an example showing the effects of the price function with 2 variables is treated. The results of the minimization with 10 variables are given and the parametric study localized in the proximity of the detected minimum. (auth)

7984 UTILIZATION OF PLUTONIUM IN THERMAL REACTORS. Schumacher, H. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen, Switzerland). Neue Tech., 8: 288-94(Oct. 1966). (In German).

Fast breeder reactors make the best use of the Pu produced in the present-time reactors and in the converters of the future. Pu might be used in the meantime economically in thermal reactors. Physical studies on the behavior of Pu in thermal reactors show it to be an interesting fissile material which can well be used in place of ^{235}U. The chemical and metallurgical properties and the behavior under irradiation of Pu-bearing U fuels are not much different from pure U fuel of the same type. The extremely high radiotoxicity of this fuel makes the technology of fabrication more difficult and influences the fuel costs. New techniques and broader experience help to overcome these difficulties. Many Pu utilization programs are under way and the results already available from theoretical studies, from fabrication and irradiation experience indicate that Pu can be a promising fuel for thermal reactors. (auth)

7985 TIME OPTIMAL SHUTDOWN OF A NUCLEAR REACTOR. Roberts, John Jacob. Berkeley, Calif., Univ. of California, 1966. 122p.

Thesis.

The buildup of ^{135}Xe following the shutdown of high flux thermal reactors with low excess reactivity may render these reactors subcritical for many hours. It has long been known that pre-shutdown power variations can modify the ^{135}Xe, ^{135}I transients to correct this problem. This reactivity-Xe shutdown problem is analyzed in terms of two optimality criteria, minimum program time and minimum peak Xe. Both point models and spatial models of the reactor are considered. Results of a shutdown experiment on the Livermore Pool Type Reactor are also presented. A time optimal criterion for the reactivity-Xe shutdown problem is formulated and solved by application of the theorems of optimal processes as developed by L. S. Pontryagin, et al. The optimal solution is shown usually to require sequential operation at zero power, variable (decreasing) power, and finally, full power. A more popular formulation of the reactivity-Xe shutdown problem is the minimax criterion in which it is desired to minimize the maximum Xe concentration given a fixed control time before shutdown to zero power. The time optimal solution is shown to be also the solution to the minimax formulation if it is required that the Xe concentration during the shutdown program be less than or equal to the maximum of the Xe concentration after the shutdown program. The minimum time solution for the point reactor model is extended to include spatial effects. The Xe importance and the nonlinear interaction between Xe and flux shapes strongly influence the optimal power trajectory. The analysis is developed first by a computer experiment on an unreflected spherical reactor. The theory is then successfully applied in an actual shutdown experiment on the Livermore Pool Type Reactor at the Lawrence Radiation Laboratory, Livermore, California. (auth)

7986 STABILITY CRITERIA FOR NUCLEAR REACTORS SUBJECT TO PERIODIC REACTIVITY PERTURBATIONS. Baxter, Alan Michael. Urbana, Ill., Univ. of Illinois, 1966. 110p.

Thesis.

Criteria for determining the stability of the power equilibrium of the reactor kinetics equations under constantly acting reactivity perturbations are presented. Particular attention is paid to the case of periodic reactivity changes of zero mean value. Only in the case of the linear reactor kinetics equations has this problem received any previous study, and the literature contains ambiguous results as to the stability of such systems. It is shown that regions of stability and instability can exist for the equilibrium of the linear kinetics equations with periodic reactivity input. The basic mathematical definitions of stability are reviewed and the techniques for determining the stability of the equilibrium of a system of differential equations are discussed. Examples are given of applications to actual systems of interest. A general criterion is derived for determining the stability behavior of the linear reactor kinetics equations under periodic reactivity perturbations. This criterion is illustrated for three specific reactivity changes: square, sinusoidal and triangular waves. A new approach for dealing with this type of perturbation is used to derive nonlinear reactor kinetics equations with temperature feedback for any general, constantly acting reactivity perturbation. Results are compared with results for the autonomous form of these equations as determined by other authors. (auth)

7987 ECONOMIC AND TECHNICAL FACTORS RELATING CURRENT WATER REACTOR TYPES TO ADVANCED CONCEPTS. Crowley, J. H.; Vann, H. E. 15p. (CONF-660606-45). ORAU. Gmelin, AED-CONF-66-203-98.

From American Nuclear Society Meeting, Denver.

The present technical and economic posture of light water power reactor development and the essential features of advanced reactor concepts, such as fast breeders and advanced converters, are related in terms of trends currently being projected by government and industrial planners. (H.D.R.)

7988 EFFECT OF DELAYED NEUTRONS ON REACTOR EXCURSIONS WITH RAMP REACTIVITY INSERTION. Canosa, Jose (General Electric Co., Pleasanton, Calif.). 6p. (CONF-660606-41). ORAU. Gmelin, AED-CONF-66-203-71.

From American Nuclear Society Meeting, Denver.

The analytical solution of the problem of reactor excursions with ramp reactivity insertion taking delayed neutrons into account is compared with results obtained with the TER computer code. The constant delayed neutron source approximation used in the analytical solution is shown to describe accurately the first power burst by the good agreement with the TER code results. (H.D.R.)

7989 THEORETICAL STUDIES ON THE FAST REACTOR MAXIMUM ACCIDENT. Hicke, E. P.; Menzies, D. C. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). 38p. (CONF-651009-23). ORAU. Gmelin, AED-CONF-65-307-37.

From Conference on Safety, Fuels, and Core Design in Large Fast Power Reactors, Argonne, Ill.

Various aspects of the course of events during and following a hypothetical melt-down accident in a large fast power reactor have been studied theoretically. A major part of the work has been concerned with estimates of the size and consequences of the energy release. Most calculations have been based on a modified form of the Bethe-Tait model. The current computer code includes a Doppler reactivity feed-back effect, and uses a more realistic equation of state than the usual energy threshold type of equation. The energy release is considerably reduced by the Doppler effect alone; the two effects together typically reduce the peak pressure to values which can hardly be regarded as explosive at all. Most energy release calculations have been based on a homogeneous spherical core model, but a modified version of the ASTRA reactor explosion code has been used for calculations on a finite cylindrical two-zone core to investigate the autocatalytic effect of the inwards motion at the zonal boundary; in typical cases the effect has been found to be quite negligible. The energy release calculations have led to the conclusion that the useful work done by the adiabatic expansion of the fuel is likely to be small in a typical fast power reactor. On the other hand, a substantial amount of energy generally remains as heat in the fuel at temperatures around 3,000°C, and the possibility that some of this residual energy might be converted into work by secondary processes has been studied in some detail. The most likely mechanism appears to be the boiling of sodium coolant, and the process could occur explosively if the hot core debris were dispersed by the primary explosion in the form of sufficiently small particles, as in the so-called SPERT incident. It is judged that the mechanical efficiency of converting the heat energy to useful work should not exceed a few percent. The damage-producing characteristics of a nuclear energy release have been compared with those of a chemical explosive such as T.N.T. The comparison indicates that the mechanical effects during the early stages of the nuclear incident, up to times of order a few seconds, can usefully be considered in terms of an equivalent charge of T.N.T., but that the two courses of events diverge substantially at later times. (auth)

7990 INDIAN POINT REACTOR NO. 1 ASYMMETRY TECHNIQUE TEST. Batch, M. L. (Babcock and Wilcox, Lynchburg, Va.); Ball, R. M.; Barringer, H. S.; Hostetler, D. R.; Wolfe, G. E.; Grobe, J. A. 15p. (CONF-660606-40). ORAU. Gmelin, AED-CONF-66-203-107.

From American Nuclear Society Meeting, Denver.

An experiment to confirm the techniques used to detect asymmetries and to establish the adequacy of the external power monitors of the Indian Point reactor is described. An asymmetry was introduced and the immediate and long-term response of the monitors was followed. Calculations were run parallel with the measurements so the monitor response could be detected. The calculational technique was successfully proved and factors influencing the monitor response were defined. (H.D.R.)

7991 METHOD AND DEVICE FOR THE CONTROL OF NUCLEAR REACTORS. Hoehne, Peter (to Siemens-Schuckertwerke Aktiengesellschaft). German Patent 1,217,517. May 26, 1966. Filed Dec. 8, 1964.

The method for the control of nuclear reactors, e.g., small power reactors, by means of control rods consists in integrating a value of a current produced by a detector located near the core of the reactor during equal and successive intervals of time, and changing the position of the control rods accordingly during equal intervals. The device comprises an analog-digital transducer for the integration signals, comparators for the logic evaluation of successive integration signals, and a common time tapper. (Gmelin)

7992 DEVICE FOR BRAKING A SHUTDOWN ROD IN A NUCLEAR REACTOR. Von Eicke, Arvid; Stuermer, Walter (to Brown, Boveri/Krupp Reaktorbau GmbH). German Patent 1,216,448. May 12, 1966. Filed May 9, 1963.

A control rod falling to the closed lower end of a control tube is provided with a pair of friction plates at its lower end for engagement with the wall of the tube. The friction plates and a piston below the friction plates and freely slidable in the tube form the movable links of a parallelogram link mechanism and the lower end of the control rod constitutes the fixed link of the mechanism. (Gmelin)

7993 ELECTROMAGNETIC COLLISION IMPULSE TRANSMITTER FOR SHUTDOWN DEVICES OF NUCLEAR REACTORS. Spies, Johannes (to Gesellschaft fuer Kernforschung mbH). German Patent 1,216,449. May 12, 1966. Filed Dec. 30, 1964.

An electromagnetic collision momentum generating device which comprises a coil, a ferromagnetic yoke, and a permanent magnet adjacent to the yoke to which the control rod is attached according to patent 1,206,536 is improved in that a mutual induction constructed in the shape of a short circuiting ring is attached to the permanent magnet. (Gmelin)

7994 CONTROL ARRANGEMENT FOR HETEROGENEOUS NUCLEAR REACTORS. Stehle, Heinz (to Siemens-Schuckertwerke Aktiengesellschaft). German Patent 1,216,450. May 12, 1966. Filed May 27, 1961.

A heterogeneous, pressurized nuclear reactor with sheathed nuclear fuel elements is controlled by means of a computer. The computer is operated according to a temperature, power, and pressure program which limits the deformation velocity of the fuel materials, e.g., the creep, in such a way that the developing of folds and leakages is prevented. The inputs of the computer are representative of the fuel element dimensions, the expansion due to heat, and of the constants of material. (Gmelin)

7995 MODERATOR REFLECTOR FAST NEUTRON REACTOR CORE. Greebler, Paul (to U.S. Atomic Energy Commission). U. S. Patent 3,267,001. Aug. 16, 1966.

A core is described for reactors in which high energy fast neutrons are the primary means for achieving a sustained fission reaction. The nuclear reactor core of this invention comprises basically concentric annular cylindriform zones of alternately arranged annuli of neutron reflector material, fissile fuel material, buffer material, and breeder blanket material concentric with a central cylindrical zone of neutron reflector material. (AEC)

7996 GAS-COOLED, WATER MODERATED NEUTRONIC REACTOR. Wood, R. E.; Niemuth, W. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,266,999. Aug. 16, 1966.

An improved gas-cooled and water-moderated active core region for a neutronic reactor is described. A multiplicity of water-moderator filled tubes are spaced apart in a hexagonal array. Gas-cooled fuel elements substantially fill the interstitial space between the moderator tubes to form a continuous fuel matrix. (AEC)

7997 PRESSURE TUBE FOR PREFERABLY HEAVY WATER-MODERATED ATOMIC REACTORS. Schabert, Hans-Peter; Roesler, Rudolf (to Siemens-Schuckertwerke Aktiengesellschaft). German Patent 1,218,075. June 2, 1966. Filed Feb. 28, 1961.

The heavy-water moderated nuclear reactor comprises a tank for containing the moderator, which is pierced by a series of upright, tubular channels. Pressure resisting tubes within the channels and spaced therefrom and shielding surrounding the moderator tank are described. Stepped sleeve extensions provided at both ends of each tube connect the tubes to the shielding. The thickness of the walls of the sleeves decreases from the shielding to the end of the pressure tubes. (Gmelin)

7998 METHOD FOR CONTROLLING A NUCLEAR REACTOR. Fromm, Leonard W., Jr.; Kelber, Charles N. (to U. S. Atomic Energy Commission). U. S. Patent 3,267,002. Aug. 16, 1966.

A method of controlling a nuclear reactor by varying the amount of a control material at the axial center of the reactor in large increments is described. After each incremental variation conventional control rods are moved axially an amount sufficient to compensate for this incremental variation, and the conventional control rods are moved to control the reactor between incremental variations in the amount of control material at the axial center of the reactor. (AEC)

7999 BOILING SUPERHEAT NUCLEAR REACTOR. Kornbichler, Heinz (to Licentia Patent-Verwaltungs-G.m.b.H.). German Patent 1,217,516. May 26, 1966. Filed Mar. 2, 1965.

A superheat reactor comprises a core consisting of an assembly of upright fuel element tubes interconnected in pairs by bottom reverse U bends, and having their bent ends immersed in the boiling liquid moderator. The steam generated outside the tubes is passed through them to be superheated. This reactor is controlled by means of plate-like control rods inserted between the fuel element units and arranged in such a way that only one fuel element tube of each pair of the interconnected tubes is immediately adjacent to a control plate position. (Gmelin)

8000 DEVICE FOR INCREASING THE HEAT TRANSFER RATE BETWEEN A FLOWING MEDIUM AND A NUCLEAR REACTOR FUEL ELEMENT. le Foll, Jean (to Commissariat a l'Energie Atomique). German Patent 1,217,511. May 26, 1966. Priority date Nov. 25, 1958, France.

The rate of heat transfer from the external wall of a fuel element having a finned heat transfer surface, to a fluid flowing along the wall, is increased by a guide member having an aerofoil cross section and arranged in the path of the fluid with the extrados facing the fuel element. The aerofoils include orifices

extending between the extrados and intrados. The aerofoil is formed as an annulus or as a helix about the fuel element, the leading edge being directed upstream. (Gmelin)

8001 IMPROVEMENTS IN AND RELATING TO PLANT FOR THE GENERATION OF SELF-MAINTAINING NUCLEAR FISSION REACTIONS BY MEANS OF NEUTRONS. British Patent 1,044,405. Sept. 28, 1966. Priority date Feb. 26, 1963, Netherlands.

A system is described to prevent the generation of a dangerous high pressure within the containment of a reactor in the event of a rupture of one of the reactor systems. The safety device consists of an expandable vessel connected to the containment shell into which the radioactive gases, vapors, and solid particles released can flow in the event of an accident. The system is particularly designed for nuclear power stations comprising more than one reactor by providing the passages connecting each containment shell with breakable membranes which permit gas flow from the containment shell side only. Provisions are also made to include a vapor condenser or a liquid lock in the system. (H.D.R.)

8002 NUCLEAR REACTOR COOLANT CIRCULATOR WITH A LIQUID SHAFT SEALING. Eibert, Paul (to Siemens-Schuckerwerke Aktiengesellschaft). German Patent 1,218,076. June 2, 1966. Filed Sept. 29, 1962.

The sealing comprises an annular gap portion between the shaft and the housing filled with a sealing liquid, and a second gap portion filled with a sealing gas, the latter portion being located adjacent to the interior of the reactor vessel. In the middle of the annular portion which is filled with gas there is a chamber connected to a storage tank containing clean reactor coolant gas. The liquid sealed portion and the gas sealed portion are separated by another chamber connected to the interior of the housing, into which the sealing liquid and the sealing gas escape and which is provided with an exit through which the gas–liquid mixture is drawn off. (Gmelin)

8003 RADIATION LEAD SCREEN. Marchal, Raymond; Chevalier, Roger; Combecave, Michel (to Commissariat a l'Energie Atomique). Canadian Patent 736,409. June 14, 1966. Priority date Sept. 1, 1961, France.

A light metal casing is filled with Pb to serve as a reactor shield. The inside surface of the casing is first coated with Cu, Ni, or Sn and this plating carefully cleaned. The casing is then placed in a mold and Pb poured on it to fill the inside and also a layer on the outside of the casing. On cooling a firm bond is formed between the Pb and the inside of the casing. This is essential to promote proper heat exchange and prevent corrosion in service. The excess lead on the outside is easily stripped away. The shield may also be traversed by cooling tubes whose outside surfaces are plated as described above. (F.S.A.)

8004 HEAT REMOVAL DEVICE. Costes, Didier (to Commissariat a l'Energie Atomique). Canadian Patent 736,373. June 14, 1966. Priority date Aug. 23, 1961, France.

A heat removal system for a reactor is proposed wherein the leakage flow, occurring after a serious failure in one zone of cooling circulation under pressure is reduced to a minimum. Instead of placing the heat exchanger and pumps in parallel with the main flow around the fuel rods, several additional valves are introduced. These extra valves allow the isolation of a leak to a relatively small portion of the system so that the normal pressure and flow in adjacent portions is maintained. (F.S.A.)

8005 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUELS. Frost, Brian Reginald Thomas (to United Kingdom Atomic Energy Authority). British Patent 1,046,965. Oct. 26, 1966. Filed Aug. 20, 1963.

A nuclear fuel material is patented that contains Hf or a compound of Hf as a burnable poison. The fuel may be a carbide fuel and contain HfC or an oxide fuel and contain HfO_2. In either case the ratio of fissile atoms to Hf atoms should be in the range of 1:5 to 1:10. The fuel material may also be enriched with Pu. (B.L.M.)

8006 IMPROVEMENTS IN NUCLEAR REACTORS. Deighton, Thomas (to Babcock and Wilcox Ltd.). British Patent 1,049,298. Nov. 23, 1966. Filed Nov. 10, 1964.

An invention relating to nuclear reactors is described in which the pressurized vessel containing the fuel core also contains the heat exchanger and the coolant liquid, which transfers heat from the core. Cooling efficiency is improved by introduction of nozzles which discharge jets of coolant into the coolant path and increase rate of flow to the heat exchanger. The jet injection pumps are connected to the output side of the conventional mechanical pumps and this arrangement avoids the necessity for circulating the whole volume of coolant through the mechanical pumps. (P.G.C.)

8007 IMPROVEMENTS IN OR RELATING TO SEALING MEANS. Hawkins, Ronald James (to Babcock and Wilcox Ltd.). British Patent 1,045,910. Oct. 19, 1966. Filed Sept. 11, 1964.

A method is described for making nuclear reactor seals by means of which a flow path for coolants, from the reactor core to heat exchangers, is formed. Ducts, which provide for circulation of coolants, are given a sealing contact by sliding blocks of graphite. The blocks are held in place, against movement caused by thermal expansion, by springs, pins, or toggle arms, but may be moved vertically or horizontally. (P.G.C.)

8008 NEUTRONIC REACTOR WITH IMPROVED RELEASE MECHANISM BETWEEN CONTROL ROD AND ASSOCIATED DRIVE. Fortescue, Peter; Nicoll, David (to U. S. Atomic Energy Commission). U. S. Patent 3,271,264. Sept. 6, 1966.

An improved lock and release mechanism is described for use between a nuclear reactor control rod and its associated drive mechanism. The mechanism includes an annular groove in the end of the control rod, a sleeve with ball-carrying recesses, a collar with recesses to receive the balls, and means for moving the collar relative to the sleeve. (AEC)

8009 NUCLEAR REACTOR FUELING MACHINE. Hummel, Frederick S. (to Atomic Energy of Canada Ltd.). Canadian Patent 738,540. July 12, 1966.

Improvements are proposed in the structure and operation of the mechanism for accurately aligning a fueling machine with a selected reactor tube. Means are provided that will tolerate some deviation of the tube from its ideal longitudinal axis. This result is achieved without resorting to finer tolerances in fueling machines than has been the practice of recent manufacturers. Gimbel mountings provide for sensing and automatically correcting pivotal displacement of the machine snout about each of the axes resulting from contact between the snout and the reactor tube. Methods for inserting and withdrawing fuel bundles without loss of coolant are described. (F.S.A.)

8010 NUCLEAR REACTOR FUELING MACHINE. Hummel, Frederick S. (to Atomic Energy of Canada Ltd.). Canadian Patent 738,542. July 12, 1966.

To avoid undesirable thermal stresses caused by sudden temperature increase in a fueling machine when it is joined to a reactor tube, an auxiliary cooling circuit is established. The interior of the machine is surrounded by an annulus through which a liquid, cooler than that from the reactor system, flows. There is some mixing of the two liquids but the pressure is kept higher in the auxiliary circuit so that the hotter reactor coolant does not raise the temperature of the machine much above 300°F though the calandria tube may reach 600°F. (F.S.A.)

8011 LIQUID METAL FAST BREEDER REACTOR. Noderer, L. C. (to U. S. Atomic Energy Commission). U. S. Patent 3,271,260. Sept. 6, 1966.

A liquid metal cooled fast breeder reactor having a negative coolant density coefficient of reactivity is described. The negative coefficient is obtained by utilizing pockets of air or inert gases in the annular space separating the core and the blanket regions. The materials used in this reactor consist of mixtures of PuO_2 and UO_2 or UC and PuC so that some fission and some breeding takes place throughout all fueled regions of the reactor. (AEC)

Marine and Portable Power Reactors

Refer also to abstracts 6768, 7932, 8089, 8090, and 8091.

8012 (MND–M3A–3146) PM-3A: SAFETY SYSTEM SET POINT ANALYSIS. Trushin, J. T.; Miller, J. K.; Petrie, T. W. (Martin Co., Baltimore, Md.). June 5, 1964. Contract AT(30-1)-3146. 95p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A performance analysis of the PM-3A primary system is presented in sufficient detail and in format permitting re-evaluation of the reactor safety system set points under changed conditions. Detailed thermal and hydraulic characteristics of the present core design are presented for the case of steady state operation. Operating limits were established with the steady state thermal restriction of no bulk boiling in the hot channel of the core. Transient analyses were conducted for transients initiated from the most severe conditions permitted by the results of the steady state analysis. These transients included loss of pumping power flow coastdown, locked pump impeller flow coastdown, cold and hot rod withdrawal accidents, and steam demand load transients. The thermal limitations imposed on the transient analysis were that departure from nucleate boiling (DNB) will not occur, and/or that the exit quality in the hot channel will not exceed 15%. In all cases, the restriction of no bulk boiling during steady state pre-

cluded DNB during a transient. Thus, the thermal operating limits are dictated by the results of the steady state analysis, under the present criteria. A summary of the accuracy of the scram instrumentation on the PM-3A plant is presented. The safety system set points are obtained from the thermal operating limits and the accuracy of the system instrumentation. A sample calculation for the determination of the maximum power scram set point is presented. (auth)

8013 NUCLEAR FUEL UNIT. Dodd, John Alan (to Societe Anglo-Belge Vulcain S. A.). U. S. Patent 3,276,967. Oct. 4, 1966. Priority date Apr. 25, 1963, Great Britain.

A fastener was developed to secure fuel units to support grids in marine reactors, so that the effect of ship movement on fuel units is restrained. The device comprises a nuclear fuel unit having an end fitting with a threaded spindle, which penetrates an aperture in the support grid, and is secured by a discontinuously threaded nut. An upper part of the nut is a ring which is reversibly deformed to lock the spindle and nut preventing rotation of the nut on the spindle. (P.G.C.)

Rocket and Space Reactors

Refer also to abstracts 6130, 6335, 6512, 6754–6756, 7932, and 8089–8091.

8014 (NAA-SR-12042) IRRADIATION TEST OF SNAP 8 ACTUATORS, POSITION SENSORS, AND LIMIT SWITCHES. Davies, N. F.; Kurzeka, W. J.; Warren, M. (Atomics International, Canoga Park, Calif.). Nov. 15, 1966. Contract AT-11-1-GEN-8. 48p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two control-drum-drive actuators, two control-drum position sensors, and two shorting-bar limit switches were tested in a combined radiation, vacuum, and high-temperature environment. The components represented the current SNAP 8 design. The purpose of the test was to evaluate the effects of the combined environment on the components prior to their use in the SNAP 8 Development System (S8DS) test. The test environment had no apparent effect on the performance of the components during any phase of the experiment. Data on coil resistances, electrical insulation resistances, and temperatures were measured in-pile throughout the experiment. (auth)

8015 (SAN-651-8) ORGANIC RANKINE CYCLE TECHNOLOGY PROGRAM. Quarterly Progress Report No. 2, July 1–October 1, 1966. Adam, A. Warren (Sundstrand Aviation-Rockford, Ill.). Contract AT(04-3)-651. 52p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A research program is being conducted to develop an organic Rankine cycle power conversion system for long-time operation in space. The working fluids to be evaluated are biphenyl and biphenyl–biphenyl ether eutectic. The program includes working-fluid, bearing, condensate-pump, and boiler investigations. Calculations on hydrogen diffusion in the test loops and progress on equipment for the investigations are discussed. (D.L.C.)

8016 AUTOMATIC PHOTOGRAPHIC SYSTEM FOR RADIOACTIVE REACTOR FUEL ELEMENTS. Kee, R. W.; PerLee, R. E.; Rose, D. G. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 340-1(Oct.-Nov. 1966).

8017 OUT-OF-PILE HEAT PIPE THERMIONIC SPACE-POWER CONCEPT. Barnett, Charles S. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 9: 338-9(Oct.-Nov. 1966).

8018 ADVANCED-SNAP-REACTOR THERMOELECTRIC SPACE-POWER SYSTEMS. Budney, G. S. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 338 (Oct.-Nov. 1966).

8019 CALORIMETRIC RADIATION HEATING RATE MEASUREMENTS AND ANALYSIS FOR NERVA REACTORS. Capo, M. A.; Gilmour, G. A. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 331-2(Oct.-Nov. 1966).

8020 REACTOR THERMAL PERFORMANCE INDEX. Varljen, Thomas C. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 9: 339-40(Oct.-Nov. 1966).

8021 COMPARISON OF MEASURED AND CALCULATED INTERNAL RADIATION ENVIRONMENT FOR THE NRX REACTORS. Nassano, R. N. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 331(Oct.-Nov. 1966).

8022 DESIGN OF PSEUDO-RANDOM-NOISE EXPERIMENTS FOR NERVA TESTS. Steiner, G. H. (Westinghouse Astronuclear Lab., Pittsburgh); James, Leslie R.; Uhrig, R. E. Trans. Amer. Nucl. Soc., 9: 328-9(Oct.-Nov. 1966).

8023 NRX/EST NUCLEAR ROCKET REACTOR TRANSFER FUNCTIONS: PART II. PRESSURE-TO-PRESSURE TRANSFER FUNCTIONS. James, L. R. (Westinghouse Astronuclear Lab., Pittsburgh); Steiner, G. H.; Bodenschatz, C. A.; Uhrig, R. E. Trans. Amer. Nucl. Soc., 9: 328(Oct.-Nov. 1966).

8024 NRX/EST REACTOR TRANSFER FUNCTIONS: PART I. POWER-TO-TEMPERATURE TRANSFER FUNCTIONS. Bodenschatz, C. A.; James, L. R.; Steiner, G. H.; Wasserman, A. A. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 327-8(Oct.-Nov. 1966).

8025 ANALOG SIMULATION OF AMBIENT-GAS EMERGENCY COOLING OF NERVA REACTOR SYSTEMS. Rovnak, J. A. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 326-7(Oct.-Nov. 1966).

8026 POST-TEST ANALOG COMPUTER ANALYSES OF THE NRX/EST NUCLEAR SUBSYSTEM. Goldberg, S. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 326 (Oct.-Nov. 1966).

8027 THE EVALUATION OF GENERATION-TIME AND TEMPERATURE-COEFFICIENT DATA FROM THE SNAPTRAN-1 EXPERIMENTS. Jackson, J. F.; Rhoades, W. A. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 324-5(Oct.-Nov. 1966).

8028 APPLICATION OF S_N-TRANSPORT MULTIGROUP ANGULAR-FLUX DATA TO PREDICT NERVA RADIATION ENVIRONMENTS. Disney, R. K.; Soltesz, R. G.; Romesburg, H. C. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 332-3(Oct.-Nov. 1966).

8029 PROMPT-NEUTRON KINETICS OF A SPHERICAL CAVITY REACTOR. Podney, Walter N.; Smith, Harold P. Jr.; Oppenheim, A. K. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc., 9: 329-30(Oct.-Nov. 1966).

8030 THE CONTROL OF A NUCLEAR REACTOR USING ^{3}He GAS CONTROL ELEMENTS. Davison H. W. (Lewis Research Center, Cleveland); Heath, C. A.; Lowen, W. Trans. Amer. Nucl. Soc., 9: 574-5(Oct.-Nov. 1966).

8031 HEAT TRANSFER FROM FUEL ELEMENTS IN A TIGHTLY PACKED, LIQUID-METAL-COOLED COMPACT REACTOR. Magee, P. M.; Tromel, R. H. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 569-70 (Oct.-Nov. 1966).

Process Heat and Desalination Reactors

Refer also to abstracts 7932 and 8089–8091.

8032 (ORNL-TM-1615) COST ALLOCATION PROCEDURE FOR DUAL-PURPOSE POWER-DESALTING PLANTS. Burwell, C. C.; Hammond, R. P. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 29p. (CONF-660449-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA Panel on Costing Procedures for Nuclear Desalination, Vienna, Austria.

A procedure for the allocation of the total cost of a power-desalting plant to the separate products is described. The cost of producing the energy required by both products includes the cost of rejecting waste heat. The production cost of energy in the form of prime steam is divided between the cost of power and water according to its potential for producing electric power. Common facilities not associated with the production of energy are allocated to water and power costs according to the use or benefit that each product receives. The method has the characteristic that for an energy source with a given capacity the water-to-power production ratio may be varied over a range of values without significantly changing the cost of either product as long as the temperature of the heat supplied to the water plant is within the useful range for the process being used. The characteristic is due to the fact that: (1) since the energy cost component of power cost is constant for a given energy source, the unit power cost varies in the relatively minor effect of the equipment and operating unit costs of the power station as a function of size; (2) the variation in exhaust steam cost to the water plant as a function of exhaust pressure is balanced by a variation in the water plant design (if optimum) to match the water plant efficiency with the cost and condition of its heat source. (auth)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 6768, 7856, 7857, 7904, and 7932.

8033 (AERE-M-1040) THE MANUFACTURE OF M.T.R. THERMOCOUPLE FUEL PLATES. Noakes, M. L.; Lloyd, H. (Atomic Energy Research Establishment, Harwell (England)). June 1962. [Revised] Oct. 1966. 24p. Dep. BIS $0.80. HMSO 4s. 0d.

A technique was developed for the introduction of thermocouples into MTR fuel plates in order to measure fuel core temperatures during operation. The standard fuel plate manufacturing procedure is employed with suitable modification to the core to allow the insertion of thermocouples at pre-determined positions. The process employs piano wire for the first two hot rolling passes to provide a passage for the insertion of thermocouples prior to the final operation during which the hot junction is embedded in the core. Mark II fuel elements each fitted with ten thermocouples strategically positioned along the fuel plates were manufactured and successfully operated in DIDO, PLUTO, and the Danish MTR at RISO. In addition, two Mark II elements each with fifteen thermocouples were manufactured to assess fuel core temperature during high power runs in DIDO. (auth)

8034 (ANL-6271(Add.)) ANALYSIS FOR LARGE FAST CRITICAL ASSEMBLIES (ZPR-6 AND ZPR-9). Rusch, G. K.; Karam, R. A. (Argonne National Lab., Ill.). July 1966. Contract W-31-109-eng-38. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Support for a requested increase of core size for ZPR-6 and ZPR-9 facilities is presented. An analysis of the proposed cores using about 1525 kg ^{235}U in a volume of about 2600 l is presented. Information is included concerning maximum credible accident, volume fractions in 2600 l carbide cores, ^{10}B rod worths, expansion coefficient, Doppler coefficient, and multiplication factor increase caused by placing moderating material near the unreflected core face. (J.R.D.)

8035 (ANL-7195) DESIGN, CONSTRUCTION DETAILS, AND PREOPERATIONAL TESTING OF AN ARGONNE FAST CRITICAL FACILITY. Dates, Leon R. (Argonne National Lab., Ill.). Apr. 1966. Contract W-31-109-eng-38. 66p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The component details and methods and procedures of construction of an Argonne fast reactor facility are described. Certain tests, and data resulting from such tests, have been included to illustrate structural stability. Accuracies of fits and alignment of mating parts, table-surface flatness, and precision leveling are given to indicate the reliability of the data taken during reactor experiments. The basic machine was designed and fabricated to tolerances that are consistent with large machine-tool fabrication. Further dimensional refinement would result in much higher cost with very little gain in reliability. The erection of the facility is discussed in a stepwise manner to provide a clear description of each part and how it fits the overall assembly. Safety and fail-safe features are explained. Much of the design criteria was dictated by experience gained from the operation of ZPR-3. Matrix deflection behavior and magnitude were predictable through studies made on the ZPR-3 matrix loadings. (auth)

8036 (BNWL-315) PHYSICS RESEARCH QUARTERLY REPORT, APRIL, MAY, JUNE 1966. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Contract AT(45-1)-1830. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results are presented of calculations made to determine the bare and water-reflected spherical critical mass of 12 of the most frequently encountered Pu compounds in the undermoderated range ($H/Pu \leq 20$). The critical masses of Pu atoms in water were also calculated for under-moderated systems. Optimum shielding research is reported on an infinitesimally thin rod designed so that particles can leave only at its ends. A theoretical analysis of optimum absorber distribution in the rod is presented. (J.R.D.)

8037 (GEAP-5092(Vol.1)) SEFOR EXPERIMENTAL PROGRAM PLANNING. VOLUME I. SPECIFICATIONS FOR THE PLANT AND EXPERIMENTAL EQUIPMENT. Pflasterer, G. R. Jr. (General Electric Co., San Jose, Calif. Advanced Products Operation). Aug. 1966. Contract AT(04-3)-540. 99p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A series of experiments, beginning with zero power physics tests, proceeding through static and frequency response tests at various power levels, and culminating in a series of sub-prompt and super-prompt critical transients is to be conducted. It appears that the planned test program can be carried out without significant restriction due to the plant design limitations. Equipment functional requirements for the major items of experimental equipment are listed. Functional requirements are set forth for the major plant equipment areas for control, instrumentation, and temperature changes. (J.C.W.)

8038 (GEAP-5099) COOLANT SURFACE TURBULENCE STUDY: SEFOR REACTOR VESSEL. Polomik, E. E.; Williams, R. F. (General Electric Co., San Jose, Calif. Advanced Products Operation). [1966]. Contract AT(04-3)-540. 53p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Half-scale test equipment was constructed to simulate the upper plenum of the SEFOR Na-cooled fast reactor for the purpose of evaluating surface conditions and gas entrainment to the coolant. Water was used as the flow medium. Tests were conducted over the flow range of 7 to 210 percent of reactor flow. Both uniform and cosine velocity profiles in the flow to the upper plenum were studied with a free surface condition. The cosine velocity distributions were also studied in three types of radiation shields immersed at various depths in the upper plenum water. The radiation shields were found to provide sufficient calming of the surface to conclude qualitatively that gas entrainment below 150 percent flow should not be a serious problem. Conditions appear satisfactory with shield heights of 9 and 7½ inches and 1 inch water over the shield surface; however, 3 inches of water or more over the shield surface results in more satisfactory conditions. Free surface conditions were considerably turbulent and conductive to gas entrainment, although very little entrainment into the loop was observed until flows in the range of 150 to 200 percent were reached. Some entrainment was noted for flow as low as 100 percent, but apparently rose in the downcomer area, where the velocity was low, and was observed rising up through the downcomer orifice holes. Flows and velocities used in the test design are higher than expected, so surface conditions are considered conservative or more severe than corresponding conditions in the reactor. Sixteen-millimeter color movies at 64 frames/sec were taken of each test geometry at about four flows and various heights. These film rolls and an edited roll showing important conditions of the entire series are on file at the General Electric NED Library at 175 Curtner Ave., San Jose, California. (auth)

8039 (GEAP-5208) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Ninth Quarterly Report, May-June 1966. Horst, K. M. (comp.) (General Electric Co., San Jose, Calif. Advanced Products Operation). Aug. 1966. Contract AT(04-3)-540. 98p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Preoperational research and development are summarized. Tasks scheduled for activity during the report period are discussed. Information is included on experimental program planning, fuel development, instrumentation, core assembly characteristics, reactivity controls, fuel handling, core design, fuel fabrication, and plant construction. (J.R.D.)

8040 (HW-63863) DESIGN CRITERIA FOR PRTR FUEL ELEMENT RUPTURE TESTING FACILITY: PROJECT CAH-867. Walkup, P. C.; Kelly, W. S.; Jakub, M. T.; Hildebrand, W. F.; Shadel, F. H. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Apr. 1, 1960. Contract AT(45-1)-1350. 128p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The PRTR fuel element rupture test facility, a system in which tests of high risk or defected fuel elements can be conducted under controlled conditions, is designed to investigate four major problem areas of reactor and fuel design: the development of fuel design features which will mitigate the rapid destruction of corrodible fuel elements whose cladding may fail during operation; the development of rupture detection instruments of high reliability and sensitivity; the definition of effective coolant system decontamination procedures, and determination of the length of time ruptured or unclad "non-corrodible" fuel elements can remain in an operating reactor. Initial use of the system will be in support of the New Production Reactor (NPR) fuel development program. In this connection, it shall provide coolant flow rates, temperatures, and water properties equal to those expected in the NPR. In addition, it shall permit post-rupture reactor operation on either recirculation or single pass operation to provide a controlled rate of background coolant activity change for rupture detection instrument tests. A means for defecting test fuel elements in the reactor environment shall be provided. Use of the system in developing or testing PRTR fuel elements requires that the system be capable of operation at coolant temperatures and fuel element heat generation rates in excess of anticipated PRTR temperatures and fuel powers. Irradiation of full size PRTR fuel elements in the facility will require use of a PRTR size pressure tube instead of the tubes described herein. (auth)

8041 (IA-1082, pp 1-19) IRR-1 REACTOR. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center).

Operational data and experimental programs of the Israel Research Reactor-1 are summarized for the year 1965. Descriptions of the reactor utilization for beam tube and thermal column experi-

ments, gamma irradiation, and radioisotope production are presented. (H.D.R.)

8042 (IAEA-3498-12) PROGRESS REPORT OF NORA PROJECT, JANUARY 1–MARCH 31, 1966. (Institutt for Atomenergi, Kjeller (Norway)). May 1966. Contract AT(30-1)-3498. 24p. (NC-74). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Reactor noise research devoted to analysis of the disagreement between the measurement and theory of Rossi-α experiments is reported. Pulsed neutron research was devoted to testing a neutron generator and preliminary reactivity measurements. Results of control rod drop measurements are included, along with results of source jerk measurements and subcritical count measurements. The calculation methods for criticality were satisfactory. Research on reactor lattice cell parameters is summarized. (J.R.D.)

8043 (IN-1049) EOCR AS A FAST REACTOR FUEL TEST FACILITY: CONCEPTUAL DESIGN. deBoisblanc, D. R.; (and others) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Mar. 1965. Contract AT(10-1)-205. 253p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A conceptual design study for converting the Experimental Organic Cooled Reactor (EOCR) to a fast reactor fuel test facility is presented. The major objective of designing several experimental facilities with adequate test performance characteristics has been accomplished by design modification of the core configuration, improved core heat transfer and changes to the primary system. The safety aspects of the converted facility have been examined to ensure that the redesigned facility does not present unacceptable hazards. (auth)

8044 (LA-3518) SOLUTION OF THE NONLINEAR REACTOR KINETICS EQUATIONS BY CONTINUOUS ANALYTIC CONTINUATION. Vigil, John C. (Los Alamos Scientific Lab., N. Mex.). May 1, 1966. Contract W-7405-eng-36. 137p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

A method known as continuous analytic continuation is proposed for obtaining approximate solutions to the nonlinear reactor kinetics equations. This method is one of the most powerful methods available for obtaining approximate solutions to systems of coupled nonlinear differential equations of any order and is well suited for digital computer application. The proposed method has several advantages over other numerical methods. The most important of these advantages is that the method yields a definitive criterion for the magnitude of the time step. Furthermore, the magnitude of the time step determined from the criterion can be much larger than the prompt neutron generation time. Approximate solutions by continuous analytic continuation are compared with analytic solutions to the reactor kinetics equations for some of the few special cases in which analytic solutions are known. The agreement between the approximate and analytic solutions is excellent, and the error accumulation in the approximate method is within the limits predicted by the theory. The reactor kinetics equations can be expressed in two different forms; one based on the prompt neutron generation time Λ and the other based on the prompt neutron lifetime l. Solutions using the two forms of the equations are compared and found to be identical for all practical purposes. Since the equations based on Λ are simpler from a mathematical viewpoint than those based on l, it is recommended that the equations based on Λ be used in all transient analyses. (J.C.W.)

8045 (LA-3625) QUARTERLY STATUS REPORT ON ADVANCED REACTOR TECHNOLOGY (ART) FOR PERIOD ENDING OCTOBER 31, 1966. (Los Alamos Scientific Lab., N. Mex.). Nov. 1966. Contract W-7405-eng-36. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Installation of UHTREX plant and instrumentation systems is nearly complete. Analytical studies of the planned program of transient experiments have begun. Summaries are included concerning the development status of the reactor components. Work in the Na-cooled reactor program includes instrumentation testing and development, heat transfer investigations and formulation of computer programs for treating the dynamic response of entire reactor plants. Plasma thermocouple work was devoted to measurements of Cs vapor pressure, development of insulation for thermionic fuel rods, investigations of stability and fabrication of Tm_2O_3–Mo thermionic fuels, and calculations on performance of cylindrical diodes. Heat pipe tests were conducted using 80-cm-long pipes containing Na. A heat transfer limit of 5500 W at 850°C was determined. Fabrication methods for W heat pipes were investigated. A summary of investigations concerning thermal neutron effects on liquid Pu fuels is included. Fabrication and properties of Ta and Nb-base materials for Pu capsules were studied. (J.R.D.)

8046 (ORNL-TM-1679) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, APRIL–JUNE 1966. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). Oct. 31, 1966. Contract W-7405-eng-26. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The operating history for the quarter was good, with the reactor at significant power levels 82.6% of the time. Two end-of-cycle shutdowns occurred, one of which was extended two days to permit the installation and checkout of the molten-salt loop at the HN-1 facility. Six unscheduled shutdowns occurred, however, unscheduled downtime was insignificant. The dual-purpose chamber for the No. 1 safety channel failed, bringing attention to the fact that two such chambers have failed far short of their expected service life. The No. 3 rod drive was replaced after a leak developed in the water seal housing. The drive itself was functioning properly but was replaced in lieu of a routine preventive maintenance and inspection procedure. No unusual wear or corrosion was found, and the unit was reassembled and placed in standby as a spare. The 24-in. reactor-inlet valve was rotated from the vertical to the horizontal position, and a new type of closing spring was introduced for use in the check valves in the primary system. Irradiation of the second ^{242}Cm production unit was completed. The molten salt loop and the HN-2 pneumatic tube were installed during the end-of-cycle-66 shutdown. The fuel-Cd shim rods were calibrated using the period method. (auth)

8047 (TID-23416) PRELIMINARY CONSIDERATIONS ON THE NORA PROJECT PROGRAMME IN 1967–1970. (Institutt for Atomenergi, Kjeller (Norway)). May 1966. Contract AT(30-1)-3498. 16p. (NC-76). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The proposed experimental program for the Norway Zero-energy Reactor Assembly is discussed. The experiments in NORA on Th-fuel will be a study of the physics parameters of uniform lattices for the reference fuel over a wide range of moderator-to-fuel range. Buckling measurements and study of cell parameters in the thermal and epithermal energy range will be carried out. The ideal fuel pellets ThO_2-$^{233}UO_2$ are not available for the project. Other fuel charges will be considered. (J.C.W.)

8048 TEMPERATURE DISTRIBUTIONS IN SODIUM FILLED IRRADIATION CAPSULES. Sullivan, A. L. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Eng., 12: 45-6 (Jan. 1967).

Temperature distributions were measured using a simulation capsule and rig. The design of the rig is described and the results are discussed. (UK)

8049 STUDY ON THE BACKGROUND CONDITIONS OF THE EXPERIMENTAL HOLE OF THE IRT OF THE ACADEMY OF SCIENCES OF THE BELORUSSIAN S.S.R. Firsov, E. I.; Rudak, E. A. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk, No. 1, 73-6(1965). (In Ukrainian).

The interfering background radiation in investigations of the γ-spectra of irradiated specimens consists of 2 components: γ-rays of the active zone scattered by the sample and collimators; and electron pairs formed in the spectrometer scintillator. Moving the specimens into the 5th section of the reactor hole slide reduced the background to a reasonable level, permitting the investigation of γ-spectra of irradiated 10-g samples. (J.R.D.)

8050 PERFORMANCE OF A LOCAL OSCILLATOR IN A NUCLEAR REACTOR: ELEMENTARY THEORY. Sellerio, A. (Istituto di Applicazioni e Impianti Nucleari, Palermo, Italy). Atti Accad. Sci., Lettere Arti Palermo, Pt. 1, 24: 35-54(1963/64). (In Italian).

A region in space which contains a neutron flux Φ, an ionization chamber C, and a small mass m of neutron absorbing material is considered. The ionization current of the current decreases in proportion to the solid angle Ω subtended by C at m. If m is set in oscillation with a frequency ν, the current becomes periodic with a fundamental ν. By filtering the current, a sine wave comes out whose amplitude depends on the cross sections Σ of the element. Using symmetry and adopting some hypothesis, formulas are derived which give amplitude in terms of Σ. (tr-auth)

8051 THE USE OF THE HFR. Snepvangers, J. J. M. Atoomenergie Haar Toepass., 8: 179-87(Aug. 1966). (In Dutch).

After a brief description of the high flux reactor, the experimental program of this reactor is considered. The physical experiments on fuel element irradiation, materials testing, and isotope production are described. (tr-auth)

8052 QUALITATIVE ANALYSIS OF THE ACTIVITIES IN THE COOLING WATER OF THE VVR-S REACTOR. Schneer-Erdeyne, Anna; Csada, Imrene; Szabo, Elek. Magyar Tud. Akad. Kozp. Fiz. Kut. Int. Kozlem., 14: 245-57(1966). (In Hungarian).

A simple method has been developed for the identification of the short-lived isotopes ^{24}Na, ^{56}Mn, and ^{64}Cu present in the cooling water circulated in the reactor core. The long-lived isotopes ^{51}Cr, ^{60}Co, ^{65}Zn, ^{113}Sn, ^{54}Mn, and ^{124}Sb had to be first separated from the water by precipitation or paper chromatography, then identified by gamma spectrometry. For Al^{3+} and Cu^{2+} ions the analysis could be performed by chemical methods after their separation by paper chromatography. (auth)

8053 MICROORGANISMS IN THE WATER CIRCUITS OF THE VVR-S REACTOR. Hortobagyi, Tibor; Jozsef, Vigassy. Magyar Tud. Akad. Kozp. Fiz. Kut. Int. Kozlem., 14: 233-43 (1966). (In Hungarian).

Living microorganisms have been detected in the water circuits of the 2.5 MW research reactor at Csillebérc exposed to radiation, namely in the secondary and the primary circuits as well as in the pool for the disposal of spent fuel elements. Four microorganisms which could be identified are described and their living conditions are discussed. It is surprising that a blue alga has been detected even in the water of the primary circuit. (auth)

8054 HOMOGENEOUS MODERATOR DETECTOR IN PULSED-NEUTRON EXPERIMENTS. McCauley, Edward W.; Albrecht, Robert W. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 9: 511(Oct.-Nov. 1966).

8055 COMPARISON OF CALCULATED TO MEASURED REACTIVITY WORTHS OF Eu_2O_3, Sm_2O_3, Gd_2O_3, Cd AND Au IN AN EPITHERMAL REACTOR. Hampel, Viktor E. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 9: 485-6 (Oct.-Nov. 1966).

8056 FEASIBILITY STUDY OF AN ACCELERATOR-BOOSTER FAST-PULSED RESEARCH REACTOR. Stevens, C. A.; Beyster, J. R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 469(Oct.-Nov. 1966).

8057 PROCEDURE FOR CALCULATING THE PARAMETERS MEASURED BY MODIFIED-PULSE-SOURCE EXPERIMENTS. Masters, Christopher F.; Cady, K. B. (Cornell Univ., Ithaca, N. Y.). Trans. Amer. Nucl. Soc., 9: 510-11(Oct.-Nov. 1966).

8058 FISSION-RATE MEASUREMENT USING REACTOR NOISE. Sastre, Cesar (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 507(Oct.-Nov. 1966).

8059 MEASUREMENT OF REACTOR NOISE BY MEANS OF A MULTISCALER ANALYZER. Ko, Y. C.; Ma, P. Y.; Chien, J. P. (National Tsing Hua Univ., Taiwan, China). Trans. Amer. Nucl. Soc., 9: 507-8(Oct.-Nov. 1966).

8060 MEASUREMENT OF GAMMA EFFECTS ON OBSERVED SUBCRITICAL POWER SPECTRAL DENSITY. Ford III, W. E.; Hanauer, S. H. (Univ. of Tennessee, Knoxville). Trans. Amer. Nucl. Soc., 9: 508-9(Oct.-Nov. 1966).

8061 SURFACE-TO-MASS AND HETEROGENEITY EFFECTS ON THE SPECIFIC REACTIVITY OF SELECTED MATERIALS IN A FAST-NEUTRON SPECTRUM. Carpenter, S. G.; Mountford, L. A.; Springer, T. H.; Tuttle, R. J. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 504(Oct.-Nov. 1966).

8062 ^{238}U FISSION-DISTRIBUTION USING STRIP AND FOILS IN A FAST ASSEMBLY. Ancarani, A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 492-3(Oct.-Nov. 1966).

8063 CAVITY REACTOR CRITICAL EXPERIMENT. Lofthouse, J. H. (General Electric Co., Idaho Falls, Idaho); Pincock, G. D.; Kunze, J. F.; Wood, R. E.; Hyland, R. E. Trans. Amer. Nucl. Soc., 9: 340(Oct.-Nov. 1966).

8064 THEORETICAL ANALYSIS OF HOMOGENEOUS PLUTONIUM CRITICAL EXPERIMENTS. Richey, C. R. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 515-16(Oct.-Nov. 1966).

8065 ANALYSIS OF PLUTONIUM/URANIUM ALLOY-FUELED HEATED-GRAPHITE EXPONENTIAL EXPERIMENTS. Lepecki, W. (Instituto de Pesquisas Radioativas da Universidade, Belo Horizonte, Brazil). Trans. Amer. Nucl. Soc., 9: 516-17 (Oct.-Nov. 1966).

8066 MEASUREMENT OF ^{241}Pu HALF-LIFE BY A REACTIVITY METHOD. Stepan, I. E.; Nisle, R. G. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 9: 451-2(Oct.-Nov. 1966).

8067 CRITICALITY OF AQUEOUS SOLUTIONS OF 5 PERCENT ENRICHED URANIUM. Webster, J. W.; Johnson, E. B. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 514-15(Oct.-Nov. 1966).

8068 FIRST CRITICAL AND PHYSICS MEASUREMENTS FOR THE ORGANIC-COOLED D_2O-MODERATED REACTOR WR-1. Hahn, O. J.; Whittier, A. C. (Canadian General Electric Co., Ltd., Peterborough, Ont.). Trans. Amer. Nucl. Soc., 9: 446-7 (Oct.-Nov. 1966).

8069 CRITICAL EXPERIMENTS WITH PuO_2–UO_2 FUEL AND D_2O MODERATOR. Kutcher, J. W.; Lauby, J. H.; Purcell, W. L.; Schmid, L. C.; Williams, L. D.; Worden, J. R. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 448-9(Oct.-Nov. 1966).

8070 THERMAL DISADVANTAGE-FACTOR MEASUREMENTS IN HIGHLY ABSORBING BORON-PLATE LATTICES. Dateo, F. H.; Galey, J. A. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 449(Oct.-Nov. 1966).

8071 SENSITIVITY OF NEUTRON-SPECTRUM-DEPENDENT QUANTITIES IN URANIUM (93.2 PERCENT U-235) METAL ASSEMBLIES TO INELASTIC SCATTERING MODELS FOR U-235. Mihalczo, J. T. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 489-90(Oct.-Nov. 1966).

8072 FAST-SPECTRUM REFRACTORY-METAL CRITICAL-EXPERIMENT MEASUREMENTS. Sims, F. L. (General Electric Co., Idaho Falls, Idaho); Kunze, J. F.; Walsh, W. P.; Henderson, W. B. Trans. Amer. Nucl. Soc., 9: 488-9(Oct.-Nov. 1966).

8073 KINETIC BEHAVIOR OF A REFLECTED FAST-BURST REACTOR. Coats, R. L. (Sandia Corp., Albuquerque, N. Mex.). Trans. Amer. Nucl. Soc., 9: 468(Oct.-Nov. 1966).

8074 SOLUTION OF THE LINEARIZED SPACE- AND ENERGY-DEPENDENT REACTOR KINETICS WITH ARBITRARY FEEDBACK. Poncelet, Claude G. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 455-6(Oct.-Nov. 1966).

8075 STABILITY ANALYSIS OF NONLINEAR REACTOR SYSTEMS. Hsu, C. (Argonne National Lab., Ill.); Bailey, Robert E. Trans. Amer. Nucl. Soc., 9: 457(Oct.–Nov. 1966).

8076 STABILITY OF THE TWO-TEMPERATURE REACTOR MODEL WITH DELAYED NEUTRONS. Meenan, Peter, Hetrick, David (Univ. of Arizona, Tucson). Trans. Amer. Nucl. Soc., 9: 458(Oct.-Nov. 1966).

8077 MEASUREMENT OF THE FAST-IMPORTANCE FUNCTION DISTRIBUTION AND OF THE GEOMETRIC BUCKLING EMPLOYING A ^{252}Cf SPONTANEOUS FISSION SOURCE. Greenspan, Ehud; Cady, K. B.; Aderhold, H. C. (Cornell Univ., Ithaca, N. Y.). Trans. Amer. Nucl. Soc., 9: 491-2(Oct.-Nov. 1966).

8078 PERIOD EFFECT IN REACTOR KINETICS. Hassan, H. H.; Miley, G. H. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc., 9: 466-7(Oct.-Nov. 1966).

8079 ROSSI-ALPHA MEASUREMENTS ON A MULTIPLE-COMPONENT LIFETIME SYSTEM. Kunze, J. F.; Pincock, G. D.; Sims, F. L.; Walsh, W. P. (General Electric Co., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 9: 467-8(Oct.-Nov. 1966).

8080 ACCURATE DELAYED-NEUTRON PARAMETER MEASUREMENTS IN A HEAVY-WATER REACTOR. Graham III, W. W. (Georgia Inst. of Tech., Atlanta); Harmer, D. S.; Cohn, C. E. Trans. Amer. Nucl. Soc., 9: 465-6(Oct.-Nov. 1966).

8081 SPECTRUM AND IMPORTANCE FUNCTION IN SPATIALLY INDEPENDENT FAST-REACTOR ASSEMBLIES. Stacey, Weston M. Jr. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 9: 474-5(Oct.-Nov. 1966).

8082 NEUTRONICS CHARACTERISTICS OF CERMET, OXIDE, AND CARBIDE DRIVER FUELS FOR THE FAST TEST REACTOR (FTR). Little, W. W. Jr.; Hofmann, P. L. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 581-(Oct.-Nov. 1966).

8083 NBSR CONVERTER TUBE. Kupiec, C. F.; Muehlhause, C. O. Trans. Amer. Nucl. Soc., 9: 582-3(Oct.-Nov. 1966).

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8085 REACTIVITY MEASUREMENTS USING NOISE TECHNIQUES. Uhrig, Robert E. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc., 9: 522-3(Oct.–Nov. 1966).

8086 SUBCRITICAL REACTIVITY MEASUREMENT USING FLUCTUATIONS FROM A PULSE-TYPE DETECTOR. Hanauer, S. H. (Univ. of Tennessee, Knoxville); Trinko, J. R. Jr.; Buhl, A. R.; Roux, D. P. Trans. Amer. Nucl. Soc., 9: 523(Oct.–Nov. 1966).

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8095 ZERO-POWER PLUTONIUM REACTOR FACILITY. Lawroski, Harry (Argonne National Lab., Idaho Falls, Idaho.). Trans. Amer. Nucl. Soc., 9: 552-3(Oct.–Nov. 1966).

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8099 CALCULATION OF FOIL EFFECTS IN THERMAL-DISADVANTAGE-FACTOR MEASUREMENTS. Weiss, S. H.; Wheat, L. L.; Glickstein, S. S.; Lehmann, P. H.; Hall, W. J. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 438-40(Oct.–Nov. 1966).

8100 ANALYSIS OF 7- AND 19-ROD UO_2 CLUSTER EXPERIMENTS WITH THE HAMMER CODE. Risti, H. A. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc., 9: 517-18(Oct.–Nov. 1966).

8101 ORGANIC-COOLED HEAVY-WATER-MODERATED ^{233}U-FUELED LATTICE EXPERIMENTS. Price, G. A.; Windsor, H.; Tunney, W.; Hellstrand, E. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 518-19(Oct.–Nov. 1966).

8102 TWO-DIMENSIONAL TRANSPORT ANALYSIS OF ABSORBER-SEGMENT WORTH MEASUREMENTS IN A FAST-SPECTRUM REFRACTORY-METAL CRITICAL EXPERIMENT. Zwick, Jacob W. (General Electric Co., Cincinnati). Trans. Amer. Nucl. Soc., 9: 519-20(Oct.–Nov. 1966).

8103 MEASUREMENT OF THE REACTIVITY WORTH OF HAFNIUM-OXIDE RODS IN A PuO_2–UO_2–H_2O LATTICE. Uotinen, V. O. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 9: 520(Oct.–Nov. 1966).

8104 AN EXPERIMENTAL DETERMINATION OF THE DANCOFF EFFECT IN FUEL-ROD ARRAYS. Glass, C. D. (General Electric Co., Cincinnati); Stubbins, W. F. Trans. Amer. Nucl. Soc., 9: 520-1(Oct.–Nov. 1966).

8105 MONTE CARLO CALCULATIONS OF THE THERMAL UTILIZATION AND DISADVANTAGE FACTOR IN URANIUM AND/OR PLUTONIUM WATER LATTICES. Nakache, F. R.; Kellman, S. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 9: 438(Oct.–Nov. 1966).

8106 ADJOINT MONTE CARLO CALCULATIONS FOR ENRICHED-URANIUM-METAL ASSEMBLIES. Morrison, G. W. (Union Carbide Corp., Oak Ridge, Tenn.); Whitesides, G. W.; Irving, D. C. Trans. Amer. Nucl. Soc., 9: 440-1(Oct.–Nov. 1966).

8107 STUDIES OF FAST-REACTOR POISON MATERIALS. Ottewitte, E. H. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 401(Oct.–Nov. 1966).

8108 TRANSIENT IRRADIATIONS OF VIBRATIONALLY COMPACTED UO_2 FUEL IN TREAT. Liimatainen, Robert C. (Argonne National Lab., Ill.); Freshley, M. D.; Testa, Frank J. Trans. Amer. Nucl. Soc., 9: 395-6(Oct.–Nov. 1966).

8109 PHOTOGRAPHIC TREAT FAST-REACTOR SAFETY EXPERIMENTS ON IRRADIATED-OXIDE PINS. Dickerman, C. E.; Robinson, L. E.; Stewart, R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 396(Oct.–Nov. 1966).

8110 AXIAL EXPANSION OF CERMET RODS DURING REACTOR TRANSIENTS. Merckx, Kenneth R. (Battelle-Northwest, Richland, Washington). Trans. Amer. Nucl. Soc., 9: 381-2(Oct.–Nov. 1966).

8111 ON THE CALCULATION OF RESONANCE PHENOMENA IN A WATER-WATER BOILING REACTOR. Sergeev, I. P. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 3, 11-16(1965). (In Russian).

Although the linear approximation customarily used to determine the stability of the reactor gives approximately correct results in most cases, there are conditions under which the nonlinearity gives rise to resonances whose frequencies do not agree with the self-oscillation frequencies obtained in the linear approximation. A method previously developed is used for the prediction of the threshold and the frequency of self-oscillations of the power of a type EBWR reactor, based on the approximate analytic investigation of the nonlinear equations of the dynamics with the aid of harmonic linearization. It is shown that under the same initial premises as in the earlier work, and under the same simplifying assumptions, it is possible to explain the disparity noted above between the self-oscillation frequencies and the frequencies of the resonant peak of the maximum of the power transient. This disparity is attributed to the fact that a boiling-water reactor of the EBWR type can be stable in the small and the region of frequencies corresponding to the middle part of the amplitude-frequency characteristic, yet unstable in the large. On the other hand, in the region of the resonance peaks, stability in the small also implies stability in the large. Possible applications of the analysis method to other variable quantities in reactor systems are briefly discussed. (ATD)

8112 POOL-TYPE NUCLEAR REACTOR WITH IMPROVED LIQUID SHIELD ARRANGEMENT. Regimbal, James J. (to U. S. Atomic Energy Commission). U. S. Patent 3,264,189. Aug. 2, 1966.

A heavy water moderated reactor with a light water shield and an upper hydrocarbon shield which is immiscible with water to isolate the heavy water of the moderator from the light water of the shield is described. This is accomplished by a cylindrical baffle which is filled with hydrocarbon and extends from above the top of the shield to a point just below the top of the reactor tank. (AEC)

8113 CORE SHIELDING FOR SWIMMING-POOL REACTORS. (to Commissariat a l'Energie Atomique). German Patent 1,217, 512. May 26, 1966. Priority date Oct. 30, 1963, France.

The core of a swimming pool reactor cooled by forced circulation of water is surrounded with a vessel constituted with juxtaposed elements made of Zircaloy for the absorption of gamma rays, and cooled by water circulating through upright channels within the wall of the vessel. Rods made of Zircaloy, which are mounted within said channels to reduce the volume of the coolant within the shielding and prevent the neutron flux from being disturbed, are used for joining the elements of the vessel and for fastening the latter to the device through which the coolant is introduced into the core. (Gmelin)

8114 SWIMMING-POOL NUCLEAR REACTOR. Ageron, Paul; Denielou, Guy (to Commissariat a l'Energie Atomique). German Patent 1,214,333. Apr. 14, 1966. Priority date Oct, 30, 1963, France.

A swimming pool reactor is described in which the power may be increased while preventing the water from boiling. The core is surrounded with a vessel provided with an access aperture. The upper extremities of the fuel elements are provided with deflectors so that the coolant, which passes through the core from bottom to top, is directed to lateral opening in the said vessel above the core and arrives into the cooling tank surrounding the vessel. The cooled and decontaminated water is partially recirculated into the

vessel through openings located in the upper part of the vessel. (Gmelin)

8115 RADIATION REACTOR. King, L. D. Percival (to U. S. Atomic Energy Commission). U. S. Patent 3,268,410. Aug. 23, 1966.

A nuclear reactor operating at a temperature in excess of 2000°C is described in which the principal means of energy transfer is by radiation. The reactor comprises a cylindrical core portion of dense graphite whose outer rim contains fissile material and a cylindrical reflector surrounding the core and consisting of high temperature material. The reflector contains both heat exchanger and research cavities and is spaced from the core. (AEC)

Production Reactors

Refer also to abstracts 8089–8091.

8116 (BNL–50006) ESTIMATION OF CHEMONUCLEAR PRODUCTION COSTS. Beller, Morris; Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Aug. 1966. Contract AT(30-2)-Gen-16. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The economic study was conducted to determine whether it is reasonable to assume fissiochemonuclear processes will hold costs down. As the supply of natural fossil fuels decreases, the cost of production of materials based on these fuels will increase. The analysis shows that chemonuclear processes may be capable of producing large quantities of utility and industrial chemicals at costs which are not significantly higher than at present. (J.C.W.)

8117 (HW–70652) CLADDING INTEGRITY OF NPR FUEL ELEMENTS ABOVE THE URANIUM MELTING POINT. Reid, D. L.; Hilliard, R. K. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 13, 1961. Contract AT(45-1)-1350. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Three New Production Reactor (NPR) fuel element sections (coextruded Zircaloy-2-clad uranium) were heated by induction in air to simulate loss-of-coolant type accidents. Isothermal conditions of either 1200 or 1300°C were reached in 6 to 8 minutes and maintained for 1 hour. Two of the elements had welded end closures; the third element had Be–Zr alloy brazed end caps. Metallographic examinations were made to determine the extent to which the claddings were destroyed by air oxidation and uranium diffusion. Micrographs of sections are presented. The pertinence of the test results to fission product release estimates is discussed. (auth)

8118 MODIFYING THE HANFORD NEW PRODUCTION REACTOR FOR ELECTRICAL POWER GENERATION. Grimm, Edwin A. (Trans. Amer. Nucl. Soc., 9: 536(Oct.–Nov. 1966).

Reactor Components, Fuels and Accessories

Refer also to abstracts 6202, 6358, 6774, 6798, 6837, 6861–6863, 6868, 6870, 6871, 6881, and 6894.

8119 (ANL–7239) DYNAMIC BEHAVIOR OF CIRCULAR PLATES AND BEAMS WITH INTERNAL AND EXTERNAL DAMPING. Cinelli, G. (Argonne National Lab., Ill.). July 1966. Contract W-31-109-eng-38. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Nuclear reactors give rise to a myriad of problems involving the dynamic behavior of elastic systems. The purpose is twofold, namely, (1) to indicate the areas in which there is a need for making structural dynamic problems an integral part of nuclear reactor design; (2) to develop some new versions of a mathematical technique, known as finite integral transforms, used in solving dynamic problems. The theory of a single-degree-of-freedom system is reviewed. The dynamic response of a circular plate under various boundary conditions is considered and the problem of a cantilevered beam is treated. The beam and plate are then treated as a complete system. The results and conclusions are presented. (W.D.M.)

8120 (CONF-660220–3) A STUDY OF THE ECONOMICS OF NATURAL UO_2, ENRICHED UO_2, PuO_2–UO_2, AND TANDEM FUEL CYCLES IN THE HEAVY WATER MODERATED REACTOR (HWR) CONCEPT. Fortune, R. F.; Penn, W. J.; Krenz, F. H. (Canadian General Electric Co. Ltd., Peterborough (Ontario). Atomic Power Dept.). Jan. 28, 1966. 41p. (R–66CAP5). Dep. mn.

From American Nuclear Society, Canadian Nuclear Assn., Nuclear Energy Resources Meeting, Toronto, Canada.

The above fuel cycles were examined in the light of probable future prices of U_3O_8, ^{235}U, Pu and prices for fabricated oxide fuel. The necessary physics calculations were performed using the CAP-31 computer program. The economics of the tandem fuel cycle were reviewed to provide a comparison with the other fuel cycles. (auth)

8121 (TRG-Report–1213) THE IRRADIATION BEHAVIOUR OF URANIUM CARBIDE/SILICON CARBIDE DISPERSED FUELS. Shennan, J. V. (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group); Sterry, F.; DeNordwall, H. J. (Atomic Energy Research Establishment, Harwell (England)). June 28, 1966. 36p. (CONF-660318–2). Dep. BIS $1.40, HMSO 7s. 0d.

From Dragon Contrators' Research and Development Symposium, Harwell, England.

The irradiation behavior of UC/SiC dispersed fuel rods incorporating SiC and pyrocarbon coated UC spheres was investigated in low- and high-temperature capsules in the Dounreay Materials Testing Reactor and also in the HTGC loop in the PLUTO reactor at Harwell. Excellent results were obtained for fuel rods containing pyrocarbon coated particles in all three types of experiment. For example, the capsule irradiation in an HPD rig at 1200°C was taken to a burn-up of 44,000 MWd/te at a rating of 1 kW/in. without any microscopic damage to the specimens, and microstructural examination revealed no irradiation damage other than the classical "spearhead" attack in the inner layers of the pyrocarbon coatings. Similar fuel irradiated in the PLUTO loop at a maximum rating of 1 kW/in. at 1250°C gave R/B for ^{133}Xe of $\sim 4 \times 10^{-6}$, and post-irradiation examination again revealed no significant change in the external appearance of the six specimens. Radiochemical examination of the loop components was made, but the surface concentrations of all fission products were often too low to measure and much longer experiments would be necessary to assess any time dependence of fission-product release and to obtain more complete distribution information. Irradiations of fuel containing SiC coated particles have generally suffered from overheating effects in both HPD and PLUTO loop experiments, when cracking of the SiC matrix occurs under the stresses produced by cycling the rods through the melting point of Si (1410°C). However, irradiation results at low temperatures (700–800°C) suggest that SiC coated fuel is inferior to pyrocarbon coated fuel. Metallographic examination reveals a much greater extent of matrix cracking, the cracks apparently being initiated at the coat-kernel interface, and there was an associated increase in the release of fission products. It is thought that cracking results from stresses set up in the inner layers of the coat by fission-fragment damage, which in the case of pyrocarbon are relieved by densification processes resulting in the phenomenon of "spearhead" attack. (auth)

8122 (GEAP–5158) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 18, February–April 1966. (General Electric Co., San Jose, Calif. Advanced Products Operation). Aug. 1966. Contract AT(04-3)-189. 112p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A program is being conducted to develop fast reactors using ceramic fuels, in particular mixed PuO_2–UO_2. Progress is reported for the following tasks: vented fuel development, transient testing of fuel, fuel performance evaluation, fast-flux irradiation of fuel, reactor physics and core analysis, and FCR cladding evaluation. (D.L.C.)

8123 (GEAP–5270) ACCURATE NUCLEAR FUEL BURN-UP ANALYSIS. Quarterly Progress Report No. 19, June–August 1966. Rider, B. J.; Ruiz, C. P.; Peterson, J. P. Jr.; Smith, F. R. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Sept. 1, 1966. Contract AT(04-3)-189. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The absolute ^{233}U thermal fission yields for stable Nd isotopes were measured on a capsule containing a weighed amount of highly enriched ^{233}U irradiated in the Materials Test Reactor for three cycles. The capsule was dissolved and analyzed by isotopic dilution mass spectrometry for the amount of U remaining and the amount of each Nd isotope. The average ^{233}U thermal fission yields from three capsules analyzed to date for ^{143}Nd, ^{144}Nd, ^{145}Nd, ^{146}Nd, ^{148}Nd, and ^{150}Nd are 5.92, 4.62, 3.39, 2.51, 1.28, and 0.49%, respectively. The 2200 meter/sec capture-to-fission ratio, α_8, was found to be 0.0954. The fissions per ml as determined by ^{148}Nd content were found from an eight-laboratory cooperative study to have single and multi-laboratory coefficients of variation (one standard deviation) of 0.8% and 1.1%, respectively. In addition, a natural Nd correction was derived for application to the unspiked Nd ratios in the ^{148}Nd procedure. (auth)

8124 (KAPL-M-6561) CYCLIC STRESS LIMITS FOR BOLTS AND STUDS. Fritz, R. J. (Knolls Atomic Power Lab., Schenectady, N. Y.). May 27, 1966. Contract W-31-109-eng-52. 36p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A review is made of the fatigue characteristics of bolts and studs. It appears that the cyclic service stresses specified for bolts by the ASME Code for Nuclear Vessels (Section III, Paragraph N416) should be revised for several reasons. The nominal stress range is too conservative; the treatment of mean stress is unrealistic; and the increase of allowable fatigue load with a decrease in material ultimate strength is inconsistent with available data. New stress limits for bolts and studs are proposed and compared with data on 198 specimens. The proposal results in a minimum factor of safety on allowable stress range of 1.75 for these 198 specimens. The specimens included bolts and studs with the following properties: size 1" to $5^1/_{18}$"; AISI 4140 and 4340; ultimate strength 130 to 170 ksi; unplated and plated with, Cu, Ag on Ni, Ag, Cr, and Cd; rolled, ground, and machined and ground threads; machined and machined and rolled bolt head fillets. The approximate cycle range of failure was 3×10^3 to 5×10^5. The tests were at room temperature and at 500°F. (auth)

8125 (ORNL-4021) THE ADEQUACY OF SCALE-UP IN EXPERIMENTS ON FISSION PRODUCT BEHAVIOR IN REACTOR ACCIDENTS. PART II. RECOMMENDED ADDITIONAL NUCLEAR SAFETY SCALE-UP EXPERIMENTS. Miller, C. E. Jr.; Browning, W. E. Jr. (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In a previous report (ORNL-3901), it was concluded that scaling of experiments on fission product release and transport in the U. S. Nuclear Safety Program does not seem adequate in that a very large extrapolation will be necessary to compare presently available data to that obtained from LOFT. Two experiments at one and ten percent the size of LOFT (based on the mass of fuel) are proposed in order to fill the gap in scaling. In the one percent scale experiment, fission products are released by melting LOFT type fuel elements in the Power Burst Facility. In the ten percent scale experiment, the fuel is melted in a LOFT core. Alternative experiments are also proposed which do not require nuclear self-heating in the fuel. In the one percent scale non-nuclear experiment, fuel is melted by center tungsten resistance heaters in the Containment Research Installation. In the ten percent experiment, the same heating method is proposed for the Containment Systems Experiment. With the addition of experiments at these two scale levels to the U. S. Nuclear Safety Program, the scaling range of experiments on fission product behavior will uniformly cover five orders of magnitude between small scale experiments and LOFT. (auth)

8126 (ORNL-P-2535) OPTIMUM UTILIZATION OF NUCLEAR FUELS. Lane, J. A. (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 19p. (CONF-660934-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA International Survey Course on Economic and Technical Aspects of Nuclear Power, Vienna, Austria.

Data are given on the growth of the U. S. nuclear power industry. On the basis of revised projections, installed nuclear capacity of the United States may reach 66,000 MWe by 1975, and 120,000 to 150,000 MWe by 1980. At present, light water reactors constitute the bulk of sales. These reactors are dependent upon low-cost U and low-cost ^{235}U separation capability of government-owned diffusion plants. Continued construction of inefficient light water reactors may lead to exhaustion of low cost resources, although these reserves may be increased to some extent by exploration. However, rising ore costs will influence power costs by increasing fuel inventory and fuel consumption costs, and it is estimated that fuel requirements for pressurized and boiling reactors, at present expansion rates, will exhaust all reserves costing less than $30.00 per pound by the year 2000. Because capacity of existing ^{235}U enrichment plants is limited, new diffusion plants must be built, but it is also essential that advanced reactors and fast breeders soon become commercially available if nuclear power is to remain competitive. (P.G.C.)

8127 VENUS ACCIDENT. Nucl. Eng., 12: 36-7(Jan. 1967).

An excursion of a critical assembly for the Vulcain project occurred on December 30, 1965. The circumstances of the accident and measurements undertaken to determine the radiation dose received by the technician handling the absorber rods are outlined. (UK)

8128 CANADIAN NUCLEAR FUEL MANUFACTURE. Fanjoy, G. R. (Hydro-Electric Power Commission, Ont.). Eng. J. (Montreal), 49: 32-6(Oct. 1966).

Manufacturing methods and current costs of Canadian nuclear power fuels from the uranium mine to the reactor are surveyed. (F.S.A.)

8129 EFFECT OF FISSION DISTRIBUTION ON CALCULATED TEMPERATURE DISTRIBUTIONS OF FUEL RODS. Anderson, W. Kermit; Hansen, Eric; Koenig, Edgar F.; Lechliter, Gerald L. (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 9: 376-8(Oct.-Nov. 1966).

8130 NUKER: A PROGRAM FOR THERMAL AND MECHANICAL ANALYSIS OF FUEL RODS. Moyar, G. J.; Koenig, E. F.; Lechliter, G. L.; Anderson, W. Kermit (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 9: 379-80 (Oct.-Nov. 1966).

8131 JEFF: A PROGRAM FOR ANALYSIS OF SWELLING OF POROUS-OXIDE FUELS. Koenig, E. F.; Moyar, G. J.; Lechliter, G. L.; Proebstle, R. A. (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 9: 378-9(Oct.-Nov. 1966).

8132 GROSS FISSION-PRODUCT POISONING IN URANIUM SYSTEMS. Hansen, E. C.; Judge, F. D.; Greenhow, R.; England, T. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 9: 481-3(Oct.–Nov. 1966).

8133 SPATIAL MEASUREMENTS OF THERMAL-NEUTRON SPECTRA AROUND A SINGLE FUEL ROD. Young, J. C.; Neill, J. M.; Brouwer, W. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 496-7 (Oct.–Nov. 1966).

8134 COMPARISON WITH EXPERIMENT OF CALCULATED DIMENSIONAL CHANGES AND FAILURE ANALYSIS OF IRRADIATED BULK-OXIDE FUEL TEST RODS USING THE CYGRO-1 COMPUTER PROGRAM. Duncombe, E.; Meyer, J. E.; Coffman, W. A. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 373-4(Oct.–Nov. 1966).

8135 TRANSIENT STRESS ANALYSIS OF CYLINDRICAL REACTOR FUEL ELEMENTS AT HIGH DEPLETION. Friedrich, C. M.; Guilinger, W. H. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 372-3(Oct.–Nov. 1966).

8136 MODIFIED ROD-DROP MEASUREMENTS. Demarmels, P.; Gozani, T.; Hurlimann, T.; Winkler, H. Trans. Amer. Nucl. Soc., 9: 527-8(Oct.–Nov. 1966).

8137 OPTIMIZATION OF REACTOR-SHUTDOWN MARGIN MEASUREMENTS IN HIGH-GAMMA FLUXES. Roux, D. P. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 523-4 (Oct.–Nov. 1966).

8138 STATUS REPORT ON BOILING-WATER REACTOR FUELS. Andersen, R. K.; Mommsen, J. T. (General Electric Co., San Jose, Calif). Trans. Amer. Nucl. Soc., 9: 538(Oct.–Nov. 1966).

8139 REMOTE MAINTENANCE THROUGH PORTABLE SHIELDS. Holz, P. P. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 532-(Oct.–Nov. 1966).

8140 UTILIZATION OF PHOTOELASTIC AND STRAIN-GAGE INSTRUMENTATION FOR TEST OF EXTERNALLY PRESSURIZED SHELL. Halle, H.; Zaleski, P. L. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 578-9(Oct.–Nov. 1966).

8141 COMPARISON OF TWO FUEL-ELEMENT SHAPES. Walter, Carl E. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 9: 574(Oct.–Nov. 1966).

8142 EFFECT OF VARIABLE WALL HEAT FLUX ON HEAT TRANSFER IN THE THERMAL ENTRANCE REGION OF REACTOR COOLANT CHANNELS. Morgan, Robert P.; Page, Robert J. (Univ. of Missouri, Columbia). Trans. Amer. Nucl. Socl, 9: 567-8 (Oct.–Nov. 1966).

8143 INFLUENCE OF AXIAL CONDUCTION ON HEAT TRANSFER TO LIQUID METALS IN REACTOR COOLANT CHANNELS. Burchill, William E.; Jones, Barclay G. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc., 9: 568-9(Oct.–Nov. 1966).

8144 COMPATIBILITY OF URANIUM NITRIDE WITH POTENTIAL CLADDING METALS. Price, David E.; Moak, Donald P. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 9: 418(Oct.–Nov. 1966).

8145 DESIGN OF HELIUM-BONDED (UPu)C FUEL-PIN CAPSULES FOR FAST-FLUX IRRADIATIONS. Cherry, B. H.; Beaulieu, C. A.; Kazi, A. H. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 9: 418-20(Oct.–Nov. 1966).

8146 TESTING OF A DESIGN ANALYSIS FOR COATED-PARTICLE FUELS. Coobs, J. H.; Beatty, R. L.; Olsen, A. R.; Krautwedel, H. L.; Prados, J. W.; Scott, J. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 421-2(Oct.–Nov. 1966).

8147 INFLUENCE OF IRRADIATION TEMPERATURE ON THE IRRADIATION STABILITY OF COATED-PARTICLE FUEL. Luby, C. S.; Goeddel, W. V. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 422(Oct.–Nov. 1966).

8148 THERMAL CONDUCTIVITY OF BEDS OF COATED FUEL PARTICLES. Stevens, D. W. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 424-5(Oct.–Nov. 1966).

8149 STAINLESS STEEL–PuO_2 CERMET IRRADIATION STUDIES. Goldsmith, Stanley; Pember, Linden (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 413-14(Oct.–Nov. 1966).

8150 ANOMALIES OBSERVED IN THE THERMAL EXPANSION OF $(Pu/U)O_2$ SOLID SOLUTIONS BY X-RAY DIFFRACTOMETRY. Roth, J. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 9: 414(Oct.–Nov. 1966).

8151 THE IRRADIATION BEHAVIOR OF VIBRATORILY COMPACTED UC 20 WT. PERCENT PuC POWDERS. Neimark, L. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 415(Oct.–Nov. 1966).

8152 FISSION-GAS RELEASE AND MICROSTRUCTURAL CHANGES IN HIGH BURNUP U–Pu FAST BREEDER ALLOYS. Beck, W. N.; Fousek, R. J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 415-16(Oct.–Nov. 1966).

8153 OXIDATION AND FLUORINATION OF SIMULATED UO_2–PuO_2 FUELS IN A FLUIDIZED-BED REACTOR. Anastasia, L.; Alfredson, P.; Steindler, M. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 416-17(Oct.–Nov. 1966).

8154 PREPARATION OF UO_2–PuO_2 FAST-REACTOR TEST SPECIMENS. Zambernard, M.; Brennan, J. L.; Thomas, I. D. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 9: 411(Oct.–Nov. 1966).

8155 POSTIRRADIATION EXAMINATION OF 20 WT. PERCENT PuO_2–UO_2 FUELS. Ross, W. J.; Caldwell, C. S.; Puechl, K. H.; Miles, J.; Shipko, F. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 9: 411-12(Oct.–Nov. 1966).

8156 IRRADIATION-INDUCED SWELLING RATES OF PuO_2–UO_2 FUEL WITH STRONG RADIAL RESTRAINT. Nelson, R. C.; Zebroski, E. L. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 9: 412-13(Oct.–Nov. 1966).

8157 FABRICATION OF FUEL ELEMENTS BY VAPOR CEMENTATION. Atkins, R. J.; Sgarlatta, D.; Ross, W. J. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 9: 413(Oct.–Nov. 1966).

8158 MATERIALS SELECTION AND DESIGN: A KEY TO QUALITY ASSURANCE. Rice, William L. R. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc., 9: 407-8(Oct.–Nov. 1966).

8159 NONDESTRUCTIVE TESTING: A KEY TO QUALITY ASSURANCE. Worlton, D. C. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 408(Oct.–Nov. 1966).

8160 GAS PERMEABILITY OF VIBRATORY COMPACTED UO_2. Batten, A. C.; Johnson, C. R. (Babcock and Wilcox Co., Lynchburg, Va.). Trans. Amer. Nucl. Soc., 9: 393(Oct.–Nov. 1966).

8161 IN-PILE MECHANICAL PROPERTIES OF NUCLEAR FUELS. Wisnyi, L. G.; Lovejoy, P. T.; Moyar, G. J.; Barnes, J. E. Jr. (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 9: 393-4(Oct.–Nov. 1966).

8162 THERMAL CALCULATIONS FOR CYLINDRICAL FUEL RODS BASED ON THE ROBERTSON CONCEPT. Anderson, W. Kermit; Mueller, Gerhard O. (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 9: 374-5(Oct.–Nov. 1966).

8163 SOME INPUT FUNCTIONS FOR COMPUTER DESCRIPTION OF FUEL PROPERTIES. PART I. THERMAL PROPERTIES. Anderson, W. Kermit; Lechliter, G. L. (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 9: 375-6(Oct.–Nov. 1966).

8164 SOME INPUT FUNCTIONS FOR COMPUTER DESCRIPTION OF FUEL PROPERTIES. PART 2. MECHANICAL PROPERTIES. Lechliter, G. L.; Anderson, W. Kermit (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 9: 376(Oct.–Nov. 1966).

8165 COMPUTER MODEL OF THE RHEOLOGICAL PROPERTIES OF NUCLEAR FUELS. Barnes, J. E. Jr.; Moyar, G. J. General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 9: 381(Oct.–Nov. 1966).

8166 NUCLEAR FUEL ELEMENT INCORPORATING HELICAL FISSIONABLE WIRE. Bloomster, Clarence H.; Hauth, Joseph J. (to U. S. Atomic Energy Commission). U. S. Patent 3,275,525. Sept. 27, 1966.

A fuel element in which a highly enriched helical wire extends through ceramic fuel of low enrichment is described. Enrichment of the fuel element is made to vary longitudinally or radially of the fuel element by a special shaping of the helix of the wire so that the pitch or the diameter of the helix varies. (AEC)

8167 FUEL ROD DESIGN. Greebler, Paul; Olich, E. E.; Horst, K. M.; Wolfe, B. (to U. S. Atomic Energy Commission). U. S. Patent 3,274,067. Sept. 20, 1966.

Fuel elements for fast neutron fission reactors are described for controlling reactivity through the Doppler broadening effect. The fuel element comprises from two to five fuel segments, each fixed at one end and movable upon thermal expansion within the cladding into a void space at the free end. Resilient restoring means is provided at the free end to permit each segment to thermally expand and contract in unison in the same direction to achieve a thermal coefficient of reactivity approaching zero. (AEC)

8168 FUEL ELEMENT. Koutz, Stanley L.; Turner, Richard F. (to U. S. Atomic Energy Commission). U. S. Patent 3,274,068. Sept. 20, 1966.

A fuel element for a gas-cooled nuclear reactor which provides for a more complete removal of fission products from the active portion of the core is described. Nuclear fuel particles are dispersed in a permeable body section which has a purge gas passageway interior to the fuel particles. Maintaining the purge passageway at a reduced pressure with respect to the cooling gas at the outer wall of the body section induces a purge flow of coolant gas radially inward from the entire outer surface of the body past the fuel particles, through the purge gas passageway to an external trapping means. Reduction in recoil damage is obtained by providing the fuel in the form of packets which include a mixture of refractory material and nuclear fuel granules of less than about 10 microns, and dispersing the packets within a matrix of moderator material. (AEC)

8169 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Hogg, Kenneth; Nugent, Brian (to International Research and Development Co. Ltd.). British Patent 1,046,624. Oct. 26, 1966. Filed May 23, 1963.

A duct system is patented for providing access to an instrument space adjacent to the inner face of the wall of a concrete shielded nuclear reactor. The system comprises a main straight duct leading from the instrument space to the outer face of the wall and a secondary duct for inserting the instrument into the main duct and branching out of the main duct between the instrument space and the outer face. The secondary duct leads to the outer face. Located within that portion of the main duct between the outer face and the junction of the main duct and the secondary duct is a removable shield plug having a metal conduit extending to an operating face of a second wall spaced from the outer wall of the reactor. The bore through the plug provides passage for an instrument control member. (B.L.M.)

8170 FUEL ELEMENTS FOR NUCLEAR REACTORS. Ritchie, William; Popple, Laurence Anthony (to English Electric Co. Ltd.). British Patent 1,046,460. Oct. 26, 1966. Filed Oct. 22, 1962.

An arrangement is provided to reduce the adhesion between two reactor fuel elements designed to be supported one on top of the other and further supported between two other fuel elements. The end of one element is provided with a recess of carbon and the opposite mating surface of the other element is stainless steel. The carbon mating surface is formed on a separate carbon member fixed to one of the end-engaging members. For further engagement, the carbon surface may include a recess and the stainless steel member, a shim. (B.L.M.)

8171 FUEL ELEMENT FOR NUCLEAR REACTORS. Perilhou, Jean; le Gargasson, Georges (to N. V. Philips' Gloeilampenfabrieken). German Patent 1,217,514. May 26, 1966. Priority date Apr. 4, 1960, France.

The fuel element comprises an envelope inside which fissile material is provided as fuel in the form of ring-shaped compact bodies. The fuel is not in contact with the envelope but is surrounded by a perforated sheath of a refractory material which does not react chemically with the fuel. (Gmelin)

8172 NUCLEAR FISSION REACTOR. Mialki, Werner; Wille, Rudolf. German Patent 1,219,135. June 16, 1966. Filed Jan. 13, 1962.

The homogeneous, thermal nuclear fission reactor according to patent 1,130, 941 is improved in that the beryllium oxide moderator and the uranium oxide fuel are dissolved in a base mixture of ceramic metallic oxides, e.g., MgO, Al_2O_3 and/or ZrO_2, and metallic carbides. The liquid state of the resulting melt is transparent for heat rays but does not solidify to a glass. (Gmelin)

8173 DOPPLER COEFFICIENT CONTROL FOR NUCLEAR REACTORS OPERATING IN THE FAST OR INTERMEDIATE NEUTRON ENERGY SPECTRUM. Greebler, Paul (to U. S. Atomic Energy Commission). U. S. Patent 3,266,998. Aug. 16, 1966.

A method for inherent control for nuclear reactors of the fast or intermediate neutron energy type is described. Inherent control is achieved by distributing moderator material in the core in a sufficient amount to moderate from 15% to 30% of the high energy or fast neutrons down into the energy range of about 10,000 eV in which range the Doppler Coefficient of Reactivity of the core is made more negative to increase neutron absorption with increase in temperature of the core. (AEC)

8174 MULTI-SECTION CONTROL ROD WITH THERMAL EXPANSION JOINT. Wimunc, Edward A. (to U. S. Atomic Energy Commission). U. S. Patent 3,264,192. Aug. 2, 1966.

A control rod formed of multilegged blade-like sections having different rates of expansion is described. The sections of the control rod are provided at their engaging ends with transverse tongues and grooves engaging one another while being kept free of connections that prevent relative movement of the sections in the directions in which the tongues and grooves extend. The control-rod sections are pressed together longitudinally and are prevented from having relative movement transverse of the tongues and grooves while being free to move relatively in the directions of the tongues and grooves. Thus, the sections are held together sufficiently for necessary longitudinal adjustment of the control rod incidental to reactor operation and yet accommodate differential expansion. (AEC)

8175 COATED NUCLEAR REACTOR FUEL PARTICLE OF UO_2 AND METHOD OF MAKING THE SAME. Blocher, John M. Jr.; Browning, Melvin F.; Dayton, Russell W. (to U. S. Atomic Energy Commission). U. S. Patent 3,290,223. Dec. 6, 1966.

A method of making fuel particles is described. The preparation steps include fluidizing UO_2 particles, hydrolyzing $BeCl_2$ in the fluidized bed to deposit a layer of BeO on the UO_2 particles, pyrolyzing hydrocarbon gas in the fluidized bed to deposit a layer of pyrolytic C on the BeO layer, and hydrolyzing $AlCl_3$ in the fluidized bed to deposit Al_2O_3 on the layer of pyrolytic C. (AEC)

8176 METHOD OF FABRICATING A MULTICHANNEL NUCLEAR FUEL ELEMENT. Allison, George S. (to U. S. Atomic Energy Commission). U. S. Patent 3,291,870. Dec. 13, 1966.

A method of making nuclear-fuel elements having many corrosion-resistant coolant channels and a high ratio of cooling surface to nuclear fuel is described. Elements, each composed of a round fuel core, a corrosion-resistant round tube enclosing the fuel core, and a round fuel tube enclosing the corrosion-resistant tube, are individually extruded to be reduced in size and to become hexagonal. The elements then are assembled in a circular container to form a generally hexagonal shape. The spaces between the hexagonal shape and the can are filled in with specially formed pieces. The assembly of can, hexagonal elements, and formed pieces are reduced in diameter; and the fuel rods are removed from the interiors of the corrosion-resistant tubes. (AEC)

8177 DISPERSION HARDENED WROUGHT URANIUM. Bufferd, Allan S.; Grant, Nicholas J.; Zwilsky, Klaus M. (to New England Materials Lab., Inc.). U. S. Patent 3,279,916. Oct. 18, 1966. Filed Aug. 16, 1963.

A method is described for producing articles of dispersion-hardened U metal in which UO_2 formation is greatly reduced, have improved physical properties at temperatures in the range of 500 to 600°C, and improved resistance to creep. Finely divided uranium hydride having a particle size of -15μ is mixed with a refractory oxide powder derived from a metal having a thermal neutron cross section not exceeding about 125 barns, and a negative free energy formation, of the oxide, at about 25°C of over 95,000 calories per gram atom of O_2. Refractory oxides which may be employed are those of Al, Be, Ce, Si, Ti, Th, and Zr. The mixed batch is vacuum compacted and hydrostatically pressed into a billet having a density in the range of 40 to 75% of full density. The compact is then simultaneously dehydrided and sintered in a vacuum of about 20μ at 500°C for 90 hr. The compact is placed in a can of deformable metal and extruded at 1150°F. After extrusion and removal of the outer skin, a cladded fuel element may be directly extruded by the method of co-extrusion. (P.B.C.)

8178 INHIBITION OF GRAIN GROWTH IN SINTERED BERYLLIUM OXIDE BODIES. Turner, P. P.; Brassfield, H. C. (to U. S. Atomic Energy Commission). U. S. Patent 3,278,454. Oct. 11, 1966.

An invention is described relating to moderator and fuel element matrix materials for high-temperature nuclear reactors comprising sintered BeO bodies incorporating 1 to 4 wt % ZrO_2 sol particles. (AEC)

GENERAL

8179 (SC-DC-66-2277) MICROBIOLOGICAL STUDIES OF LAMINAR FLOW ROOMS. Whitfield, W. J. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1966. Contract AT(29-1)-789. 18p. (CONF-661106-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Annual Convention of the Parenteral Drug Association, New York.

The laminar flow concept and how laminar flow devices control airborne particles are described briefly. Data are shown for total particle (viable and nonviable) counts for various types of laminar flow systems. A review is made of various types of microbiological studies conducted in laminar flow rooms, and preliminary results are presented for a laminar flow hospital operating room. (auth)

8180 (SC-RR-66-149) STUDY OF 280-MM GUN AS A TOOL FOR UPPER ATMOSPHERIC RESEARCH. Lathrop, Wayne (Sandia Corp., Albuquerque, N. Mex.). Nov. 1966. Contract AT(29-1)-789. 46p. Dep. mn. CFSTI $3.00 cy, $0.60 mn.

An estimate of the capability of the 280-mm gun as a research tool to perform upper atmospheric studies for Sandia's Aerospace Nuclear Safety Program is presented. Performance characteristics of the 280-mm gun are compared with those of the 16-inch and 7-inch guns presently used for upper atmospheric studies by the Ballistic Research Laboratory, Aberdeen Proving Ground, and McGill University, Montreal. (auth)

8181 (SC-RR-66-385) MICROBIOLOGICAL STUDIES RELATING TO CLEAN ENVIRONMENTS. PART I. EVALUATION OF THE EFFICIENCY OF A CLASS 100 LAMINAR-FLOW CLEAN ROOM FOR VIABLE CONTAMINATION CLEANUP. Beakley, John Wm.; Whitfield, W. J.; Mashburn, J. C. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1966. Contract AT(29-1)-789. 8p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A laminar-flow wall-to-floor clean room was challenged with Bacillus subtilis spores and then tested for efficiency of cleanup using both electronic and viable particle detection systems. The results confirmed the extreme efficiency of laminar-flow systems in reducing airborne viable particles to an absolute minimum. (auth)

8182 (Y-1559) INDUSTRIAL INTERFEROMETRY. Whitten, L. G. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Dec. 7, 1966. Contract W-7405-eng-26. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

After three-hundred years, the science of interferometry is being accepted in industrial environments. Its progress has been slow, but it is now a useful shop tool. It can be used for the measurement of linear distance, straightness, flatness, and surface finish. It is adaptable to use either as the control or the feedback of tape-controlled machine position. (auth)

8183 TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY 1966 WINTER MEETING, OCTOBER 30–NOVEMBER 3, 1966, PITTSBURGH, PENNSYLVANIA. Farmakes, Ruth (ed.). Trans. Amer. Nucl. Soc., 9: 323-629(Oct.–Nov. 1966). (CONF-661001).

Summaries of papers presented at the 1966 Winter Meeting are included under the categories Aerospace, Shielding, Materials, Physics, Reactor Operations, Power, Reactor Technology, Mathematics, Isotopes and Radiation, Education, and Remote Systems Technology. Titles are listed in NSA for each paper. (H.D.R.)

For titles of individual papers see: 5798–5803, 5925–5927, 5976, 6087, 6104–6116, 6136–6140, 6152–6157, 6162, 6170–6177, 6251–6256, 6324, 6349, 6369, 6512–6521, 6566, 6567, 6659–6661, 6764, 6766, 6767, 6774–6777, 6810–6812, 6841–6850, 6860–6863, 6894–6896, 6900, 7040, 7049, 7303–7328, 7646–7680, 7754, 7755, 7803, 7908–7980, 8016–8031, 8054–8110, 8118, 8129–8165, 8184, and 8185.

8184 UTILITY VIEWS ON QUALITY ASSURANCE. Bailey, Eugene C. (Commonwealth Edison Co., Chicago). Trans. Amer. Nucl. Soc., 9: 410(Oct.–Nov. 1966).

8185 A CRITICAL REVIEW OF NUCLEAR CODES AND STANDARDS AVAILABLE AND UNDER DEVELOPMENT IN THE UNITED STATES. Chalker, Ralph G. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 408-9(Oct.–Nov. 1966).

8186 SOURCES OF INFORMATION ON ATOMIC ENERGY. Anthony, L. J. International Series of Monographs in Library and Information Science. Volume 2. New York, Pergamon Press, 1966. 254p. $8.00.

The principal organizations that are sources of information on atomic energy and of the literature published in this field are considered. The various aspects of atomic energy and their relation to each other and to other technologies are discussed in an introductory chapter. Information sources in the British Commonwealth, the United States, the Soviet Bloc, France, Italy, Japan, Federal Republic of Germany, Sweden, Belgium, Netherlands, Switzerland, Norway, and Denmark are described. International sources of information and published sources of information are discussed. (M.C.G.)